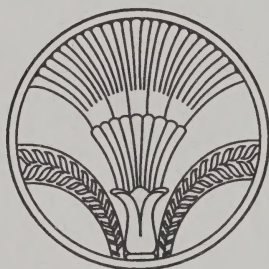


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NEW SPECIES OF NEOFUSCELIA AND XANTHOPARMELIA (LICHENIZED ASCOMYCOTINA: PARMELIACEAE) FROM ZIMBABWE

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ABSTRACT : The following new lichen species are described: *Neofuscelia domboensis* Elix & U. Becker, *N. thorstenii* Elix & U. Becker, *Xanthoparmelia barthlottii* Elix & U. Becker, *X. hondensis* Elix & U. Becker, *X. hypothamnolica* Elix & U. Becker, *X. notatica* Elix & U. Becker, *X. subumbilicata* Elix & U. Becker and *X. zimbabweana* Elix & U. Becker. The natural occurrence of the depsides, 2-*O*-methyl-3- α -hydroxybarbatic acid and 2-*O*-methylbaeomycesic acid, is reported for the first time.

Introduction

The work described in this paper has arisen from a study of the vegetation and biodiversity of inselbergs located in the tropics and is supported by the Deutsche Forschungsgemeinschaft (DFG). Zimbabwe and the Ivory Coast were chosen as the major African study sites as they have large numbers of inselbergs and represent different floristic regions with significant higher and lower plant diversity (Barthlott *et al.* 1993; Porembski & Barthlott 1992; Porembski *et al.* 1999; Seine *et al.* 1998). As a result of our study on representatives of the lichen family Parmeliaceae in Zimbabwe, we are describing eight new species. This study complements our work on the Parmeliaceae of South Africa (Elix 1997, Nash & Elix 1987). Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson *et al.* 1981; Culberson &

Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Feige et al. 1993) and comparison with authentic samples.

Neofuscelia domboensis Elix & U. Becker, sp. nov.

Fig. 1

Species cum thallo ut in *Neofuscelia namaensis* sed ab hac specie laxe adnato, lobis separatis, subtus nigro et acido bourgeanico non continente differt.

Type: Zimbabwe. Eastern Highlands, Mount Dombo, inselberg N of road from Rusape to Nyanga, 18°17'08"S, 32°38'50"E, 2005 m, on granite rock, U. Becker 218426, 28 March 1994; holo: KOELN.

Thallus minute foliose to subcrustose, saxicolous, loosely adnate to adnate, 1-2 cm wide. *Lobes* not imbricate, separate, sublinear, subdichotomously to irregularly branched, 0.2-0.8 mm wide. *Upper surface* dark brown to black-brown, convex, shiny, lacking isidia and soredia; becoming areolate in thallus centre. *Medulla* white. *Lower surface* wrinkled, black; rhizines sparse, robust, becoming expanded and hapterate, dark brown or black. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K-, HNO₃+ pale to dark blue-green, medulla K+ yellow then orange, C-, P+ orange-red; containing norstictic acid (major), connorstictic acid (minor).

The only other morphologically similar nonisidiate, small foliose to subcrustose species of *Neofuscelia* with convex lobes which produce norstictic acid as the major medullary constituent are *N. namaensis* (J. Stein. & Zahlbr.) Essl. and *N. convexa* Elix. However, both of these species have a pale tan lower rather than a black lower surface. *N. namaensis* also differs in having a tightly adnate thallus, crowded lobes and in producing bourgeanic acid in addition to norstictic and connorstictic acids. In gross morphology *N. convexa* more closely resembles *N. domboensis*, since both species have small subcrustose, moderately adnate to adnate thalli, but the latter has broader (0.2-0.8 mm vs. 0.1-0.3 mm wide) and more markedly revolute lobes, as well as having a black lower surface. At present *N. domboensis* is only known from the type locality.

Specimen Examined

ZIMBABWE. Type locality, on granite, rocks U. Becker 218425 (CANB).

Neofuscelia thorstenii Elix & U. Becker, sp. nov.

Fig. 2

Species cum thallo ut in *Neofuscelia crustulosa* sed ab hac specie laxe adnato et acido hypothamnolico, acido lobarico, acido sublobarico et acido oxolobarico continente differt.

Type: Zimbabwe. Mambo Hills, 19°31'S, 29°04'E, 1300 m, on granite rock, *U. Becker* 242024, 19 Feb. 1994; holo: KOELN; iso: CANB.

Thallus small foliose to subcrustose, tightly adnate to adnate, to 1-3 cm wide. *Lobes* contiguous to slightly imbricate, irregular, short, rounded, irregularly branched, 0.2-0.8 mm wide. *Upper surface* dark brown to black-brown, flat or weakly convex, dull or slightly shiny at the lobe apices, lacking isidia and soredia, becoming markedly rugose and wrinkled in the thallus centre. *Medulla* white. *Lower surface* dull, pale brown, sparsely or only very obscurely rhizinate; rhizines vestigial, brown; lower cortex in part agglutinated directly to substratum. *Apothecia* common, sessile, becoming short stipitate, to 0.6 mm wide; disc concave, dark brown; thalline exciple entire. *Ascospores* ellipsoid, 8-9 x 4.5-5.5 µm. *Pycnidia* not seen.

Chemistry. Cortex K-, HNO₃+ pale to dark blue-green, medulla K+ pale purple, C+ pale red, KC+ violet, P-; containing lobaric acid (major), hypothamnolic acid (submajor), sublobaric acid (submajor), oxolobaric acid (minor).

This new species is characterized by the subfoliose to subcrustose thallus, the pale brown lower surface, the lack of isidia and the unique medullary chemistry. Morphologically *N. thorstenii* is very similar to *N. crustulosa* (Essl.) Essl., as both species have similar nonisidiate, small foliose to subcrustose thallii, with ±flat lobes. However, *N. crustulosa* is more distinctly subcrustose and more tightly adnate than *N. thorstenii*. Further, *N. crustulosa* produces hypostictic, hyposalazinic and 4-O-methylhypoprotocetraric acids rather than the lobaric acid chemosyndrome and hypothamnolic acid present in *N. thorstenii*. This species is named in honour of our mutual friend and well known German lichenologist, H. Thorsten Lumbsch. At present *N. thorstenii* is known from two localities in Zimbabwe.

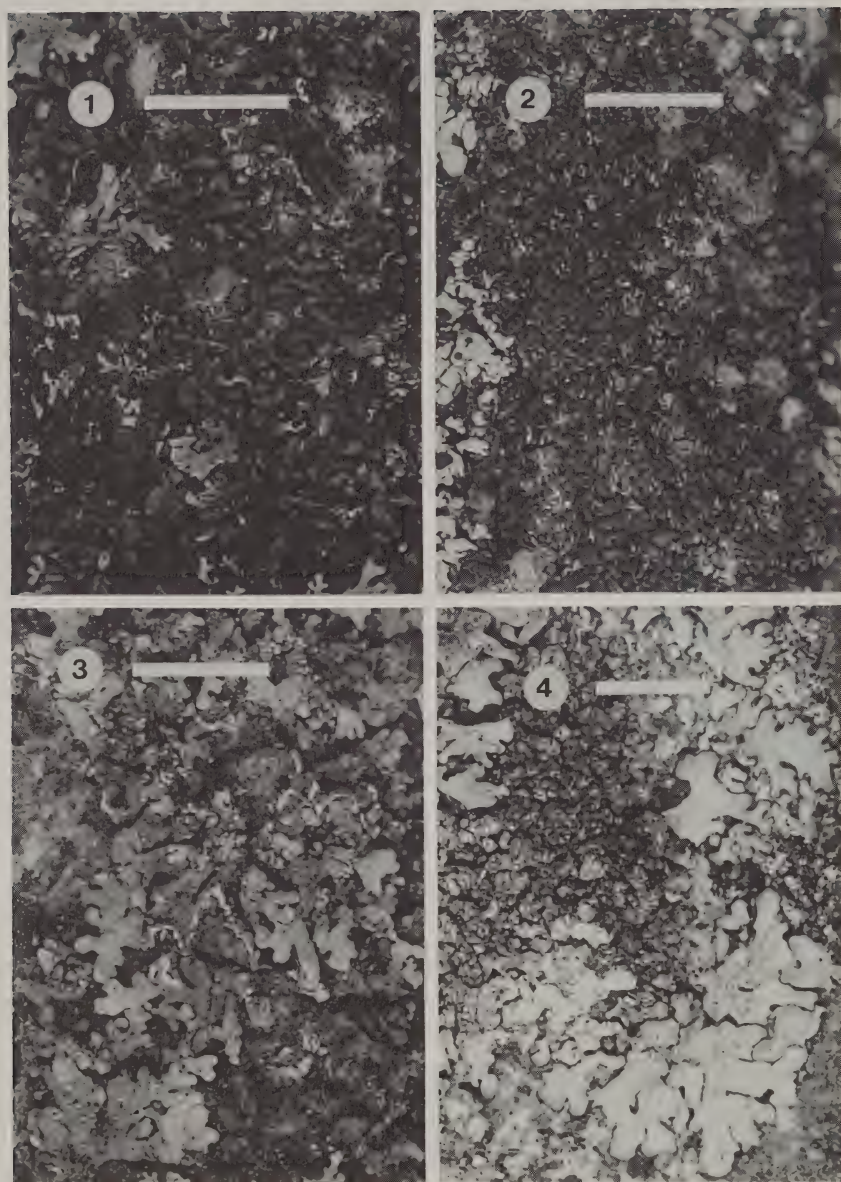
Specimen Examined

ZIMBABWE. Domboshava, inselberg N of Harare, 17°36'S, 31°10'E, 1640 m, on granite rock, *U. Becker* 243244B, 23 Feb. 1994 (CANB).

Xanthoparmelia barthlottii Elix & U. Becker, sp. nov.

Fig. 3

Species cum thallo ut in *Xanthoparmelia tenacea* sed ab hac specie apiciis isidiis syncorticato et non erumpentibus differt.



Figures 1-4. New species of Parmeliaceae: 1, *Neofuscelia domboensis* (holotype in KOELN); 2, *N. thorstenii* (holotype in KOELN); 3, *Xanthoparmelia barthlottii* (holotype in KOELN); 4, *X. hondensis* (holotype in KOELN). Scale bar = 5 mm

Type: Zimbabwe. Dinde, road from Bulawayo to Hwange, inselberg, 54.8 km from Gwayi, 18°23'S, 26°45'E, 780 m, on sandstone rock, *U. Becker* 206277, 15 Feb. 1994; holo: KOELN; iso: CANB.

Thallus small foliose to subcrustose, tightly adnate, to 2-3 cm wide. *Lobes* imbricate or not, flat, sublinear to irregular, irregularly branched, 0.6-1.0 mm wide, $\pm$ older lobes irregularly fractured and areolate. *Upper surface* yellow-green, shiny at least towards the apices, emaculate, lacking soredia but sparsely to moderately isidiate, the isidia globose to subcylindrical, $\pm$ inflated, simple, apices pale, syncorticate. *Medulla* white. *Lower surface* shiny, pale brown to brown; rhizines sparse to moderately dense, concolorous. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-; medulla K+ pale yellow then red, C-, KC-, P+ orange-red; containing usnic acid, salazinic acid (major), consalazinic acid (minor).

This species is characterised by the small foliose to subcrustose, tightly adnate thallus, the globose isidia, pale lower surface and the production of salazinic acid and consalazinic acid in the medulla. The overall morphology and chemistry is very reminiscent of *Xanthoparmelia tenacea* Knox & Hale from Namibia, but the latter species is distinguished by isidia where the apices are in part epicorticate, erumpent and eroding. In contrast, *X. barthlottii* produces isidia with syncorticate, intact apices. This species is named in honour of Professor Dr Wilhelm Barthlott of the University of Bonn.

Specimen Examined

ZIMBABWE. Chibono Road, inselberg, 2.8 km beyond turnoff, on sandstone, 18°18'S, 26°35'E, 900 m, *U. Becker* 208160, 18 Feb. 1994 (KOELN).

Xanthoparmelia hondensis Elix & U. Becker, sp. nov.

Fig. 4

Species cum thallo ut in *Xanthoparmelia endochrysea* sed ab hac specie lobis latioribus et acido echinocarpico continente differt.

Type: Zimbabwe. Eastern Highlands, Honde View, 18°44'S, 32°36'E, 1750 m, on granite rock, *U. Becker* 219124, 17 July 1993; holo: KOELN.

Thallus small foliose, adnate, 2-3 cm wide. *Lobes* imbricate, flat or weakly convex, subirregular to sublinear, irregularly branched, 0.8-2.0 mm wide. *Upper surface* yellow-green, shiny at least near the lobe apices, emaculate, lacking soredia; lobe margins smooth; isidia in thallus centre, subglobose to cylindrical, simple or sparingly branched towards the apices, not inflated, apices syncorticate, shiny, blackening. *Medulla* white. *Lower surface* pale tan to light brown; lobe apices darker, shiny; rhizines moderately dense, simple, short, concolorous or blackening. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-; medulla K+ pale yellow, C+ pale yellow-orange, P+ yellow; containing usnic acid, hypoprotocetraric acid (major), 4-O-demethylnotatic acid (major), echinocarpic acid (major), conhypoprotocetraric acid (trace).

This species is characterised by the adnate thallus, the imbricate lobes with a pale lower surface, the cylindrical isidia with syncorticate apices and the production of hypoprotocetraric, echinocarpic and 4-O-demethylnotatic acids in the medulla. This new species is probably related to *Xanthoparmelia endochrysea* (Müll. Arg.) Hale, which has similar isidia, a pale lower surface and similar chemistry, but lacks echinocarpic acid. However, *X. endochrysea* has narrower lobes (0.5-1.2 mm cf. 0.8-2.0 mm wide) as well as differing chemically. *Xanthoparmelia hondensis* is only the third species of *Xanthoparmelia* known to contain echinocarpic acid. The other two species, *Xanthoparmelia echinocarpica* Nash & Elix from South America, and *X. putsoa* Hale from South Africa, are nonisidiate and have a jet black lower surface. Further, *X. echinocarpica* contains conechinocarpic acid and *X. putsoa* gyrophoric acid, in addition to the medullary echinocarpic acid. At present this new species is only known from the type collection.

***Xanthoparmelia hypothamnolica* Elix & U. Becker, sp. nov.**

Fig. 5

Species cum thallo ut in *Xanthoparmelia dubitata* sed ab hac specie thallo majore, lobis latoribus et acido hypothamnolico continente differt.

Type: Zimbabwe. Domboshava, inselberg N of Harare, 17°36'S, 31°10'E, 1640 m, on granite rock, U. Becker 243245, 23 Feb. 1994; holo: KOELN.

Thallus small-foliose to subcrustose, very tightly adnate, to 1-6 cm wide. **Lobes** sparingly imbricate, contiguous, flat or weakly convex, irregular to sublinear, irregularly branched, 0.2-0.7(-1.0) mm wide. **Upper surface** yellow-green, shiny at least near the lobe apices, emaculate, often becoming rugose and areolate in the thallus centre, lacking soredia and isidia. **Medulla** white. **Lower surface** pale brown; rhizines sparse, short, simple, brown to black. **Apothecia** common, sessile to substipitate, 0.5-1 mm wide; disc concave then ±flat, dark brown to black; thalline exciple smooth, entire. **Ascospores** 8-9 × 5-6 µm. **Pycnidia** common, immersed. **Conidia** elongate-bifusiform, 7-8 × 1 µm.

Chemistry. Cortex K-; medulla K+ pale purple, C+ pale red, KC+ violet, P-; containing usnic acid, hypothamnolic acid (major), norlobaridone (minor), lioxodin (minor).

This species is characterised by the very tightly adnate, subcrustose thallus, the narrow, irregular to sublinear lobes, the pale brown lower surface and by the production of norlobaridone and hypothamnolic acid in the medulla. This unique combination of characters distinguish *X. hypothamnolica* from

all other species of *Xanthoparmelia* (Hale 1990). Morphologically and chemically *X. hypothamnolica* resembles the Australian species, *X. dubitata* Elix & J. Johnst., but this species differs in having somewhat smaller thalli (2-4 cm cf. 1-6 cm wide) and narrower lobes (0.2-0.5 mm cf. 0.2-1.0 mm wide) as well as differing chemically (*X. dubitata* lacks hypothamnolic acid). *X. hypothamnolica* is only the second species of *Xanthoparmelia* known to contain hypothamnolic acid. The other species, *Xanthoparmelia thamnolica* (Knox) Hale, is loosely adnate, foliose, and has a densely isidiate upper surface.

Specimen Examined

ZIMBABWE. Type locality, on granite, rocks *U. Becker* 243244A (CANB).

Xanthoparmelia notatica Elix & U. Becker, sp. nov.

Fig. 6

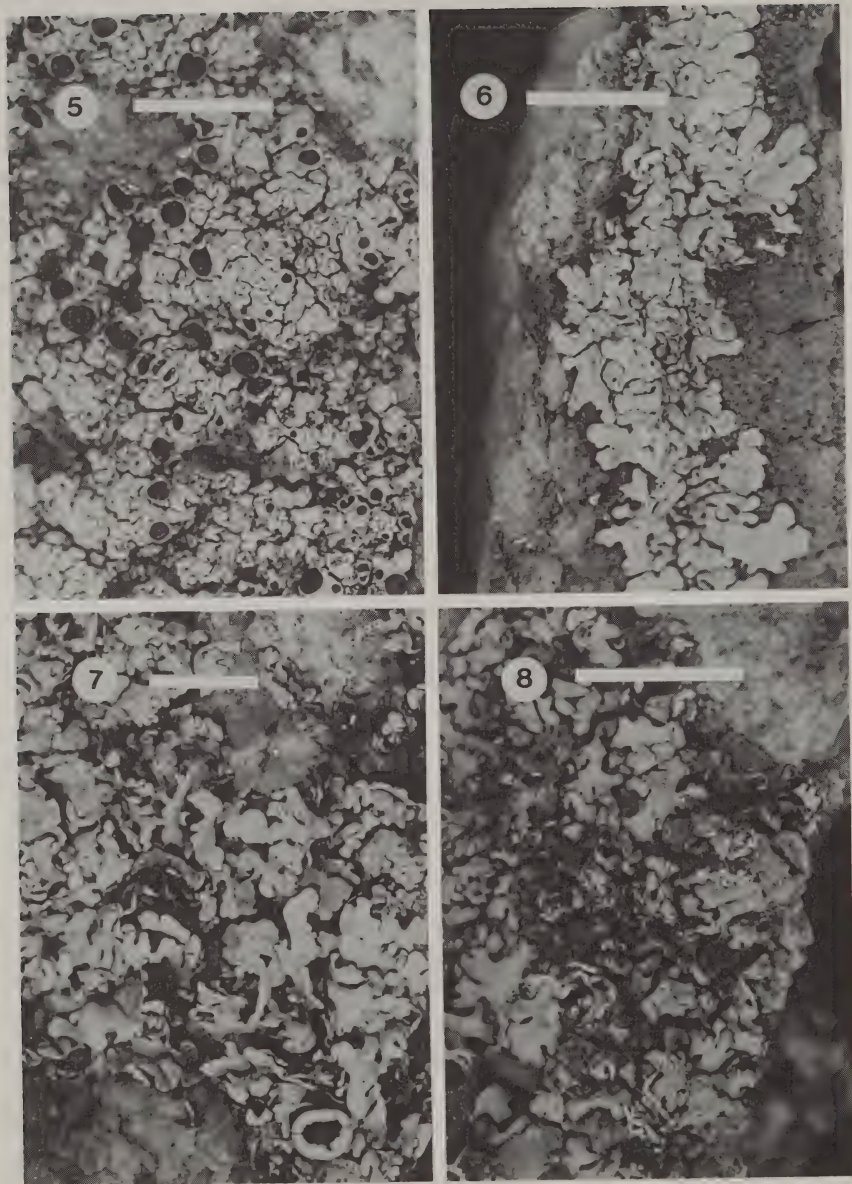
Species cum thallo ut in *Xanthoparmelia weberi* sed ab hac specie thallo parviore, lobis angustioribus et acido 4-O-methylhypoprotocetrarico et acido notatico continente differt.

Type: Zimbabwe. Lake Kyle Recreation Park, inselberg, 20°12'S, 31°02'E, 1060 m, on granite rock, *U. Becker* 222141, 21 July 1993; *holo:* KOELN.

Thallus small foliose, adnate, 1-3 cm wide. *Lobes* imbricate, flat or weakly convex, subirregular to sublinear, irregularly branched, 0.5-1.5 mm wide. *Upper surface* yellow-green, shiny at least near the lobe apices, emaculate, lacking soredia; lobe margins smooth; isidia in thallus centre, initially globose, cylindrical to irregularly inflated at maturity, simple or sparingly branched with age, apices epicorticate, dull brown, very weakly erumpent. *Medulla* white. *Lower surface* pale tan to light brown; lobe apices darker, shiny; rhizines moderately dense, simple, short, concolorous or blackening. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-; medulla K-, C-, KC -, P-; containing usnic acid, 4-O-methylhypoprotocetraric acid (major), notatic acid (minor), hypoprotocetraric acid (minor), 4-O-demethylnotatic acid (trace).

This species is characterised by the adnate thallus, the narrow, imbricate lobes with a pale lower surface, the cylindrical isidia with weakly epicorticate apices and the production of 4-O-methylhypoprotocetraric and notatic acids in the medulla. This new species is probably related to *Xanthoparmelia weberi* (Hale) Hale, which has similar isidia, a pale lower surface and contains medullary hypoprotocetraric and 4-O-demethylnotatic acids. However, *X. weberi* has larger thalli (3-7 cm cf. 1-3 cm wide) and broader lobes (0.8-3.0 mm cf. 0.5-1.5 mm wide) as well as differing chemically. *X. notatica* is only the second species of *Xanthoparmelia* known to contain the rare lichen substance, notatic acid. The other species,



Figures 5-8. New species of *Xanthoparmelia*: 5, *X. hypothamnolica* (holotype in KOELN); 6, *X. notatica* (holotype in KOELN); 7, *X. subumbilicata* (holotype in KOELN); 8, *X. zimbabweana* (holotype in KOELN). Scale bar = 5 mm.

Xanthoparmelia notata (Kurok.) Hale, is nonisidiate, has prominent effigurate maculae on the upper surface and a jet black lower surface. At present this new species is only known from the type collection.

***Xanthoparmelia subumbilicata* Elix & U. Becker, sp. nov.**

Fig. 7

Species cum thallo ut in *Xanthoparmelia albomaculata* sed ab hac specie lobis emaculatibus et acido hypostictico et acido hypoconstictico continente differt.

Type: Zimbabwe. Eastern Highlands near Troutback, inselberg a at Stanhope Block, 18°11'15"S, 31°46'15"E, 2290 m, on granite rock, *U. Becker* 250062, 22 March 1994; *holo:* KOELN.

Thallus foliose, tightly adnate, to 5-8 cm wide. *Lobes* imbricate or not, flat or commonly subascending, sublinear to irregular, rarely irregularly branched, 1.0-3.0 mm wide, with rotund apices; in part appearing subumbilicate. *Upper surface* yellow-green, shiny at least towards the apices, emaculate or white maculate, lacking soredia and isidia; lobe margins smooth. *Medulla* white. *Lower surface* shiny, jet black, the centre of the lobes often attached directly to the substrate; rhizines very sparse or commonly absent, short, simple or agglutinated, black. *Apothecia* rare, sessile, 1-3 mm wide; disc concave, dark brown; thalline exciple smooth, margin thick, crenulate. *Ascospores* ellipsoidal, 9-11 x 4.5-5.5 µm. *Pycnidia* common; conidia bifusiform, 5-6 x 0.5 µm.

Chemistry. Cortex K-; medulla K+ pale yellow-brown, C-, KC-, P+ brick red; containing usnic acid, stictic acid (major), hypostictic acid (minor), constictic acid (minor), hypoconstictic acid (minor), cryptostictic acid (minor).

This species is characterised by the tightly adnate thallus, the subascending lobes with an erhizinate, black lower surface, the subumbilicate attachment of the lobes and the production of stictic acid and hypostictic acids in the medulla. The lack of rhizines, the black lower surface and medullary stictic acid are reminiscent of *X. albomaculata* Hale, but the latter differs in having distinctly or effigurately maculate lobes and in lacking hypostictic and hypoconstictic acids. The only other nonisidiate, African *Xanthoparmelia* with a black lower surface which contains both the stictic and hypostictic acid chemosyndromes is *X. medusina* (Brusse) Elix. However, this species has linear-elongate lobes which are loosely adnate or unattached to the substrate.

Specimens Examined

ZIMBABWE. Rhodes Matopos National Park, Pomongwe, 20°32'S, 28°30'E, 1470 m, on granite, *U. Becker* 226193, 226199, 1994 (KOELN); type locality, on granite, rocks, *U. Becker* 250040, 22 March 1994 (CANB).

Species cum thallo ut in *Xanthoparmelia blackdownensis* sed ab hac specie laxe adnato, lobis imbricatis, et acido squamatico, acido 2-O-methylsquamatico et acido 2-O-methylbaeomycesico continente differt.

Type: Zimbabwe. Eastern Highlands near Troutback, inselberg a at Stanhope Block, 18°11'00"S, 31°46'12"E, 2249 m, on granite rock, *U. U. Becker 251103*, 23 March 1994; holo: KOELN.

Thallus small foliose, moderately adnate, 1-3 cm wide. Lobes imbricate, flat or weakly convex, subirregular to sublinear, irregularly branched, 0.5-1.2 mm wide. *Upper surface* yellow-green, shiny at least near the lobe apices, emaculate, lacking soredia; lobe margins smooth; isidia in thallus centre, cylindrical, simple, apices syncorticate, shiny, blackened. *Medulla* white. *Lower surface* pale tan to light brown; lobe apices darker, shiny; rhizines moderately dense, simple, short, concolorous or blackening. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-; medulla K-, C-, KC -, P-; containing usnic acid, diffractaic acid (major), 4-O-demethyldiffractaic acid (minor), squamatic acid (trace), 2-O-methylsquamatic acid (trace), 2-O-methyl-3- α -hydroxybarbatic acid (trace), 2-O-methylbaeomycesic acid (trace).

This species is characterised by the moderately adnate thallus, the narrow, imbricate lobes with a pale lower surface, the cylindrical isidia with syncorticate apices and the production of diffractaic acid in the medulla. Most of these features are also observed in the Australian species *X. blackdownensis* Elix & J. Johnst., but the latter differs in being more tightly adnate, in having non- or barely imbricate lobes and isidia, with pale tipped, syncorticate apices. These two species also contain different, minor medullary substances. Thus *X. blackdownensis* contains minor or trace quantities of 4-O-demethylbarbatic acid and 3- α -hydroxybarbatic acid, whereas *X. zimbabweana* contains 4-O-demethyldiffractaic acid, squamatic acid, 2-O-methylsquamatic acid, 2-O-methyl-3- α -hydroxybarbatic acid and 2-O-methylbaeomycesic acid. This is the first reported natural occurrence of the latter two compounds although they have been prepared synthetically and characterized previously (Elix *et al.* 1989). The characteristic TLC data for these substances follows: 2-O-methyl-3- α -hydroxybarbatic acid exhibited standard TLC R_F values, R_F (A) 0.20; R_F (B) 0.20; R_F (C) 0.25; standard HPLC, R_T 22.1 min.; R_I 0.21: 2-O-methylbaeomycesic acid exhibited standard TLC R_F values, R_F (A) 0.36; R_F (B) 0.25; R_F (C) 0.35; standard HPLC, R_T 23.4 min.; R_I 0.23.

At present this new species is only known from the type collection. It is probably related to *X. thamnolica*.

New Record for Africa

Xanthoparmelia remanens (Elix) Elix & J. Johnst., *Bull. Brit. Mus. (Nat. Hist.), Bot.* 15: 314 (1986).

Previously this species was known only from Australia.

Specimen Examined

ZIMBABWE. Rhodes Matopos National Park, Pomongwe, 20°32'S, 28°30'E, 1470 m, on granite, U. Becker 226204, 1994 (KOELN).

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STUDIES IN CHAETOSPHAERIA SENSU LATO III. UMBRINOSPHAERIA GEN. NOV. AND MIYOSHIELLA WITH SPORIDESMIUM ANAMORPHS

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ABSTRACT

Two lignicolous genera *Miyoshiella* and *Umbrinosphaeria* with *Sporidesmium* anamorphs are referred to the Trichosphaeriaceae. They are separated on the basis of the anatomy of the ascospores. The genus *Miyoshiella* is resurrected and three species are included, viz. *M. fusispora* is accepted, a new combination: *M. triseptata* is proposed and a new species *M. larvata* is described. A key to species of *Miyoshiella* is provided. The new genus *Umbrinosphaeria* is described with the single species *U. caesariata*, a new combination for *Lasiosphaeria caesariata*. *Chaetosphaeria ampulliformis* is considered, its affinity to *Umbrinosphaeria* and *Miyoshiella* and other genera of the Trichosphaeriaceae and Chaetosphaeriaceae are discussed.

Key words. Ascomycotina, Chaetosphaeriaceae, Trichosphaeriaceae, wood-inhabiting fungi, systematics.

INTRODUCTION

During a revision of nonstromatic lignicolous species currently placed in *Chaetosphaeria* Tul. & C. Tul. and *Lasiosphaeria* Ces. & de Not. three species, viz. *Chaetosphaeria fusispora* (Kawamura) Hino, *Lasiosphaeria triseptata* Shoemaker & White and *L. caesariata* (Clinton & Peck) Sacc., were found to be associated with *Sporidesmium* Link anamorphs (Hino, 1932; Shoemaker & White, 1985; Saccardo, 1883).

The anamorph of *Lasiosphaeria caesariata* is *Sporidesmium hormiscioides* Corda. It has transversely 7-septate versicoloured ascospores, the middle cells turning brown and the end cells remaining hyaline; perithecia superficial, nonstromatic and covered with scattered sterile setae (Saccardo, 1883; Shoemaker & White, 1985). The anamorph of *Lasiosphaeria triseptata* Shoemaker & White is *Sporidesmium adscendens* Berk. (Shoemaker &

White, 1985), and the anamorph of *Chaetosphaeria fusispora* (Kawamura) Hino is *Sporidesmium bambusicola* M.B. Ellis (Kawamura, 1907; Hino, 1932). Both species have transversely 3-septate, hyaline ascospores and superficial, nonstromatic, glabrous perithecia. Two recent collections of a pyrenomycete associated with *Sporidesmium larvatum* Cooke & Ellis, having transversely 3-septate, fusiform, hyaline ascospores and glabrous, superficial perithecia, were made on *Abies alba* in the Czech Republic.

Based on the type and other herbarium material all these species differ radically from the generic concepts of *Chaetosphaeria* (Tulasne & Tulasne, 1863; Booth, 1957, 1958) and *Lasiosphaeria* (Cesati & de Notaris, 1863) where they were previously included (e.g. Saccardo, 1883; Hino, 1932; Wehmeyer, 1942; Shoemaker & White, 1985).

Chaetosphaeria, the type genus of the Chaetosphaeriaceae Réblová & al. (Réblová, Barr & Samuels, 1999), possesses superficial, globose to subglobose perithecia with a brittle, thin perithecial wall that comprises thin-walled, dark brown, opaque, brick-like cells; the hamathecium consists of persistent, tapering paraphyses and periphyses arising from the same inner meristem; asci arise in croziers; the ascal apex has a pronounced, J- apical annulus; ascospores are ellipsoidal to fusiform, generally hyaline, 1-3 transversely septate and germinate by a germ tube. The anamorphs exclusively have enteroblastic-phialidic conidiogenesis and belong to several genera of dematiaceous hyphomycetes (Réblová & al., 1999).

Lasiosphaeria (Cesati & de Notaris, 1863) is clearly distinct from *Chaetosphaeria* in having superficial or partly immersed perithecia that are pyriform to conical; the peridium is leathery to partly carbonaceous, wide, light pigmented brown and comprises angular, thick-walled cells; the ascal apex has a subapical chamber, a plasmatic globule and a J- apical annulus; paraphyses are filiform; ascospores are cylindrical bent in the lower third, 0-multi-septate, hyaline or becoming yellowish to pale brown with age, germinating by both germ tube and phialide; the known anamorphs have enteroblastic-phialidic conidiogenesis and belong to *Phialophora* Medlar (Gams, 1973).

On the basis of the perithecial peridium, ascal anatomy and conidiogenesis of *Chaetosphaeria* and *Lasiosphaeria* neither proved to be a home for the four species associated with *Sporidesmium* anamorphs. Their peridium is wide, comprising thick-walled, dark-brown, angular cells with opaque walls; asci do not arise from croziers and do not contain a plasmatic globulus or subapical chamber at the apex and the conidiogenesis is holoblastic. These species can be divided into two groups on the morphology of the ascospores, viz. species with 3-septate, hyaline ascospores on the one hand and species with 7-septate, versicoloured ascospores. In other respects,

such as the presence of a distinct J- apical annulus; persistent, apically free paraphyses and periphyses; globose to subglobose, papillate perithecium, anatomy of the peridium and conidiogenesis, all species are similar. The species with 3-septate, hyaline ascospores are accommodated in *Miyoshiella* Kawamura (Kawamura, 1929) that was placed by Hino (1932) in synonymy of *Chaetosphaeria*. In *Miyoshiella*, *M. fusispora* Kawamura is accepted, a new species *M. larvata* is described and a new combination *M. triseptata*, for *Lasiosphaeria triseptata*, is proposed. *Lasiosphaeria caesariata* with 7-septate, versicoloured ascospores, setose perithecia, characteristic anatomy of the peridium and the associated anamorph could not be identified with any of the known genera of pyrenomycetous ascomycetes. Therefore, a new genus *Umbrinosphaeria* is described with the single species *U. caesariata*, a new combination for *L. caesariata*. Another four species are considered, viz. *Chaetosphaeria caespitulosa* Höhnelt, *C. caelestinoides* S. Teng, *C. multiseptata* Wehmeyer and *C. pezizaeformis* Schulzer, and their relationships with *U. caesariata* are discussed. *Umbrinosphaeria* is closely related to *Miyoshiella* from which it is separated on the basis of the septation of the ascospores.

Species of *Umbrinosphaeria* and *Miyoshiella* are saprobes on woody substrata, e.g. on decorticated, decaying trunks and stumps, and are also often collected on worked and utilized wood, for instance on decorticated timber, on slivers or on railway sleepers.

Single ascospores of *Umbrinosphaeria caesariata* and single conidia of *Sporidesmium larvatum* were cultured. Except for these species, only conserved herbarium material was available for the investigation. Therefore, the teleomorph-anamorph connections could be only proved for *U. caesariata* by culture studies. On the other hand, the regular association between the teleomorph and the anamorph of all species make those connections highly probable. Shoemaker and White (1985) were unable to culture *Umbrinosphaeria caesariata* and *Miyoshiella triseptata* (as *Lasiosphaeria triseptata*).

The anatomy of the perithecial wall of *Miyoshiella* and *Umbrinosphaeria* is distinct from that of *Chaetosphaeria* and *Lasiosphaeria* and suggests rather anatomy of *Phaeostrichosphaeria* Sivan., with *Endophragmiella* B. Sutton anamorph (Sivanesan, 1983), and *Iodosphaeria* Samuels & al., with *Selenosporiella* Arnaud ex Macgarvie and *Ceratopodium* Schw. synanamorphs (Samuels & al., 1987). On the basis of related anamorphs and anatomy of the perithecial wall *Iodosphaeria*, *Phaeostrichosphaeria*, *Miyoshiella* and *Umbrinosphaeria* form a unit that is distinct from *Chaetosphaeria* and *Lasiosphaeria* and the Chaetosphaeriaceae and Lasiosphaeriaceae, respectively, and represent a group of related

teleomorphs and anamorphs within the Trichosphaeriaceae G. Winter order Trichosphaeriales M.E. Barr.

Chaetosphaeria ampulliformis Sivan. & Chang (Sivanesan & Chang, 1997) is considered and its relationships with *Miyoshiella* and other genera are discussed.

Recently, Subramanian (1992) redefined the generic concept of *Sporidesmium* which he considered to be heterogenous. He distributed species currently placed in *Sporidesmium* sensu lato (Ellis, 1958, 1971, 1976) among nine genera, considering several characters to have the diagnostic value, e.g. euseptate and distoseptate conidia, absence or presence of conidiophores and conidiophore proliferation. Species having nonproliferating conidiophores or conidiophores with infrequent percurrent proliferation were placed in *Sporidesmium* s. str., where conidia are euseptate and in *Ellisembia* Subram., where conidia are distoseptate. Species with conidiophores characterized by a single, terminal, annellate conidiogenous cell and euseptate conidia were placed in *Repetophragmia* Subram. and those with distoseptate conidia in *Sporidesmiella* P. M. Kirk. Species having conidiophores with lageniform, dolliiform or nodose percurrent proliferation and euseptate conidia were transferred to *Penzigomyces* Subram. and those with distoseptate conidia in *Polydesmus* Subram. The genus *Stanjehughesia* Subram. accommodates species that lack conidiophores and have euseptate conidia that are produced directly on simple conidiogenous cells. Other *Sporidesmium* species were transferred to *Acarocybellina* Subram., *Gangliophora* Subram., *Hemicorynesporella* Subram. and *Janetia* M. B. Ellis (Subramanian, 1992). Subramanian's concept was followed by McKenzie (1995) who described another species and made new combinations in these genera. Hernández-Gutiérrez & Sutton (1997) redescribed *Polydesmus* and introduced two new genera, *Imimyces* A. Hern. & B. Sutton and *Linkosia* A. Hern. & B. Sutton, as segregates from *Sporidesmium* sensu lato. Their concept of *Sporidesmium* is not accepted by the present author. The characters such as conidial septation or conidiophore proliferation used by Subramanian (1992) and Hernández-Gutiérrez & Sutton (1997) in separating 11 genera from *Sporidesmium* sensu lato and the known teleomorph-anamorph connections are considered and discussed.

MATERIALS AND METHODS

For materials and methods refer to the first part of this series of publications (Réblová, 1999a).

Single ascospores of *Umbrinosphaeria caesariata* and single conidia of *Sporidesmium larvatum* were isolated with the aid of a single-spore isolator on CMA agar. Colonies grew on CMA, MEA, OA and PCA, colony characters were taken from PCA cultures grown 10 days at 25° C in darkness and 10 days at 23° C in cool white fluorescent light. The cultures of *U. caesariata*, and *S. larvata* are deposited in the Institute of Botany in Průhonice.

TAXONOMIC PART

***Umbrinosphaeria* Réblová, gen. nov.**

Perithecia superficialia, solitaria usque gregaria, subglobosa usque globosa, ostiolata, papillata, setosa. Pariete ascomatibus bistratosa, strato externo cellulis angulatis, parietibus incrassatis valde obscuris, haud pellucidis. Ostiolum periphysatum. Hamathecium cum paraphysibus persistentibus cylindraceis. Asci unitunicati, 8-sporei, cylindracei, non amyloidei, annulo apicali refractivo. Ascosporae fusiformes, maturae 7-septatae, versicolores, cellulis centralibus brunnescentibus, cellulis apicalibus permanentiter hyalinis.

Species typica. Umbrinosphaeria caesariata (Clinton & Peck) Réblová

Perithecia superficial, solitary to gregarious, subglobose to globose, ostiolate, papillate, setose.—Peridium consisting of two layers; outer layer of thick-walled, dark brown, opaque, angular cells.—Ostiole canal periphysate.—Paraphyses persistent, cylindrical, septate.—Asci unitunicate, 8-spored, cylindrical; apex with J-, refractive apical annulus.—Ascospores fusiform, 7-septate, versicoloured, the middle cells becoming brown, the end cells remaining hyaline.

TYPE SPECIES. *Umbrinosphaeria caesariata* (Clinton & Peck) Réblová

ANAMORPH. *Sporidesmium* Link, Mag. Ges. Nat. Freunde 3: 41, 1809.

SYSTEMATIC POSITION. Trichosphaeriaceae G. Winter, Trichosphaeriales M.E. Barr

ACCEPTED TAXA. *Umbrinosphaeria caesariata* (Clinton & Peck) Réblová

HABITAT. Saprobe on woody substrata, commonly on utilize wood.

KNOWN DISTRIBUTION. Probably widespread in temperate North America (Canada, U.S.A.), Europe (Austria, Czech Republic, Croatia, Slovak Republic, Ukraine) and Asia (China).

ETYMOLOGY. „umbrino“ is derived from the latin *umbrinus* = umber, refering to the colour of the perithecial wall; „sphaeria“ is derived from the latin *sphaericus* = globose, refering to the shape of the perithecium.

Umbrinosphaeria caesariata (Clinton & Peck) Réblová, comb. nov.

Figs. 1-14.

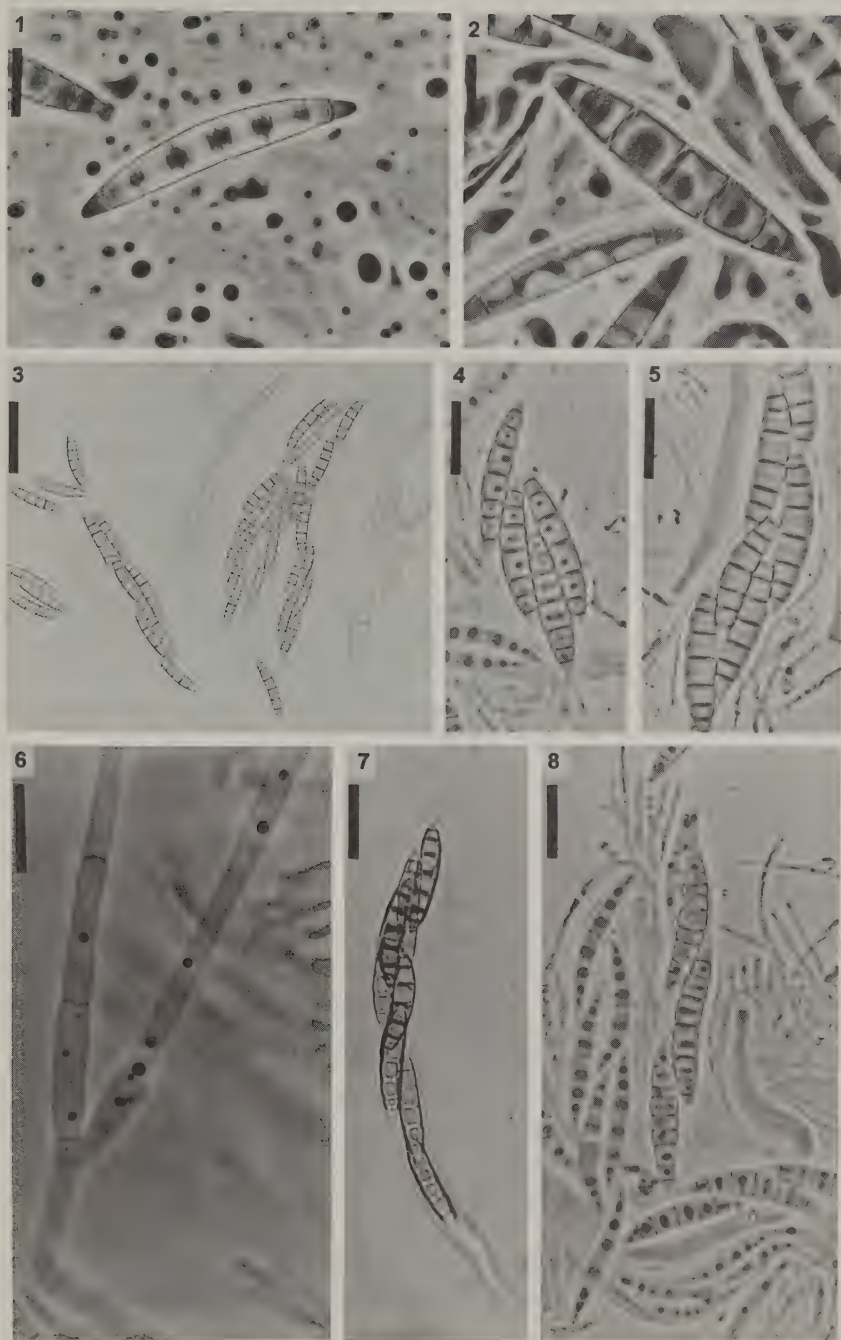
- = *Sphaeria caesariata* Clinton & Peck, Ann. Rep. New York State Mus. Nat. Hist. 29: 60, 1878. - basionym.
- = *Lasiosphaeria caesariata* (Clinton & Peck) Sacc., Syll. Fung. 2: 192, 1883.
- = *Phaeotrichosphaeria caesariata* (Clinton & Peck) M.E. Barr, Bull. New York State Mus. 459: 1-74, 1986.
- = *Chaetosphaeria caelestinoides* S. Teng, Sinensia 7: 502, 1936.
- = *Chaetosphaeria caespitosa* Höhnelt, in Weese, Mittell. Bot. Inst. Techn. Hochschule Wien 6: 97, 1929.
- = *Chaetosphaeria multiseptata* Wehmeyer, Canad. J. Res., Sect. C, 20: 576, 1942.
- = *Chaetosphaeria pezizaeformis* Schulzer, Hedwigia 23: 78, 1884.

ANAMORPH. ***Sporidesmium hormiscioides*** Corda, Icones Fung. 2: 6, 1838. Fig. 14.

- = *Clasterosporium hormiscioides* (Corda) Sacc., Syll. Fung. 4: 383, 1886.
- = *Stanjehughesia hormiscioides* (Corda) Subram., Proc. Indian Natn. Acad. Sci., Ser. B58, 4: 184, 1992.
- = *Clasterosporium vermiculatum* Cooke, Grevillea 4: 69, 1875.
- = *Sporidesmium vermiculatum* (Cooke) M.B. Ellis, Mycol. Pap. 70: 41, 1958.
- = *Stanjehughesia vermiculata* (Cooke) Subram., Proc. Indian Natn. Acad. Sci., Ser. B58, 4: 184, 1992.

Perithecia superficial, sparsely scattered in the dark mycelium of the anamorph, globose to subglobose, papillate, 350-550 µm wide and 400-450 µm high, ostiolate, dark brown to nearly black, glabrous, slightly verrucose, often sparsely covered with conidiophores of the anamorph and sterile setae.—Setae scattered, erect, 40-100(-140) µm long, 4-7 µm wide in the middle and 8-11 µm wide at the top, consisting of two parts; the lower part cylindrical, dark brown, septate, thick-walled, arising from the ascomatal wall; the upper part separated by a septum from the lower part and formed of

Figs. 1-8. ***Umbrinosphaeria caesariata***. - 1, 2. Ascospores. - 3. Asci with ascospores and paraphyses. - 4, 5. Ascospores. - 6. Paraphyses. - 7. Ascus with ascospores. - 8. Ascospores. - Figs. 1, 2, 4-6, 8: PC; 3, 7: BF. - Figs. 1-3, 7 from Herb. M. Réblová 922/97; 4, 5, 8 from DAOM 166653; 6, 7 from DAOM 189168a. - Scale bars: 1, 2, 6 = 10 µm; 3 = 50 µm; 4, 5, 7, 8 = 20 µm.



the amorphous, subhyaline, clavate to almost triangular globule.—Peridium firm, consisting of two layers. Outer layer 29-55 μm wide, comprising thick-walled, dark brown, opaque, angular cells that are on the surface heavily pigmented; inner layer 7-11 μm wide, of thin-walled, subhyaline to hyaline, flattened, elongated cells.—Ostiole canal periphysate.—Paraphyses persistent, abundant and extending beyond the asci, hyaline, apically free, somewhat inflated and branched at the base, septate, cylindrical, 3-4(-5) μm wide, slightly tapering towards the top, 2-3 μm wide at the apical end.—Asci unitunicate, 8-spored, (105-)127-154(-158) $\times$ 13-15.5(-20) μm , cylindrical, stipitate, truncate above, apex with a shallow, J-, refractive apical annulus.—Ascospores fusiform, straight or inequilateral, (38-)40-47.5(-55) $\times$ (6-)7-8.5 μm , 7-septate at maturity, with a delayed formation of septa which develop in the sequence 4:3:2:1:2:3:4, the middle cells turning brown and the end cells remaining hyaline, the two middle cells are the largest ones, some over-ripe ascospores rarely observed with 12 septa, young ascospores not constricted at the septa, mature and over-ripe ascospores strongly constricted at the septa, each cell with one large oil drop, 2-3-seriate in the upper part and obliquely 1-seriate in the lower part of the ascus.

CHARACTERISTICS IN CULTURE. Ascospores germinating after 10 days, forming germ tubes at one or both ends.—Colonies on PCA extremely slow growing, reaching a 1.5-2 mm diameter in 10 days at 25° C in darkness, colonies cultivated for another 10 days at 25° C in cool white fluorescent light reaching 2-3 mm diameter. Colonies velvety, grey, reverse dark greyish; conidial production scarce at the margins.—Aerial mycelium scant, grey; mycelium mostly immersed, hyphae 2-3 μm wide, septate, mid brown.—Conidiophores immersed in agar medium, arising singly or in groups of 2-3 directly from hyphae of substrate mycelium, semi-macronematous, reduced to the conidiogenous cells, monoblastic, terminal, determinate, simple, erect, ampulliform, nonseptate, pale brown to reddish brown, 10-18 $\times$ 4-7.5 μm .—Conidia holoblastic, forming singly from the conidiogenous cell, the bottom part of the conidium always immersed in agar medium; straight or curved in the upper part, clavate when young, cylindrical to fusiform at maturity, rounded at the distal end, apical cell subhyaline, truncate at the proximal end and 4-6.5 μm wide at the base, dark brown to reddish brown, 10-20-septate, at septa darker brown, 92-176 μm long and 10-14.5 μm wide in the broadest part, conidial masses dark brown to black. Conidium secession schizolytic

MATERIAL EXAMINED. 1) Type material. U.S.A. New York, Portville, on rotten wood, Sept. 1875, G. W. Clinton, ex herbarium Dearness 4674

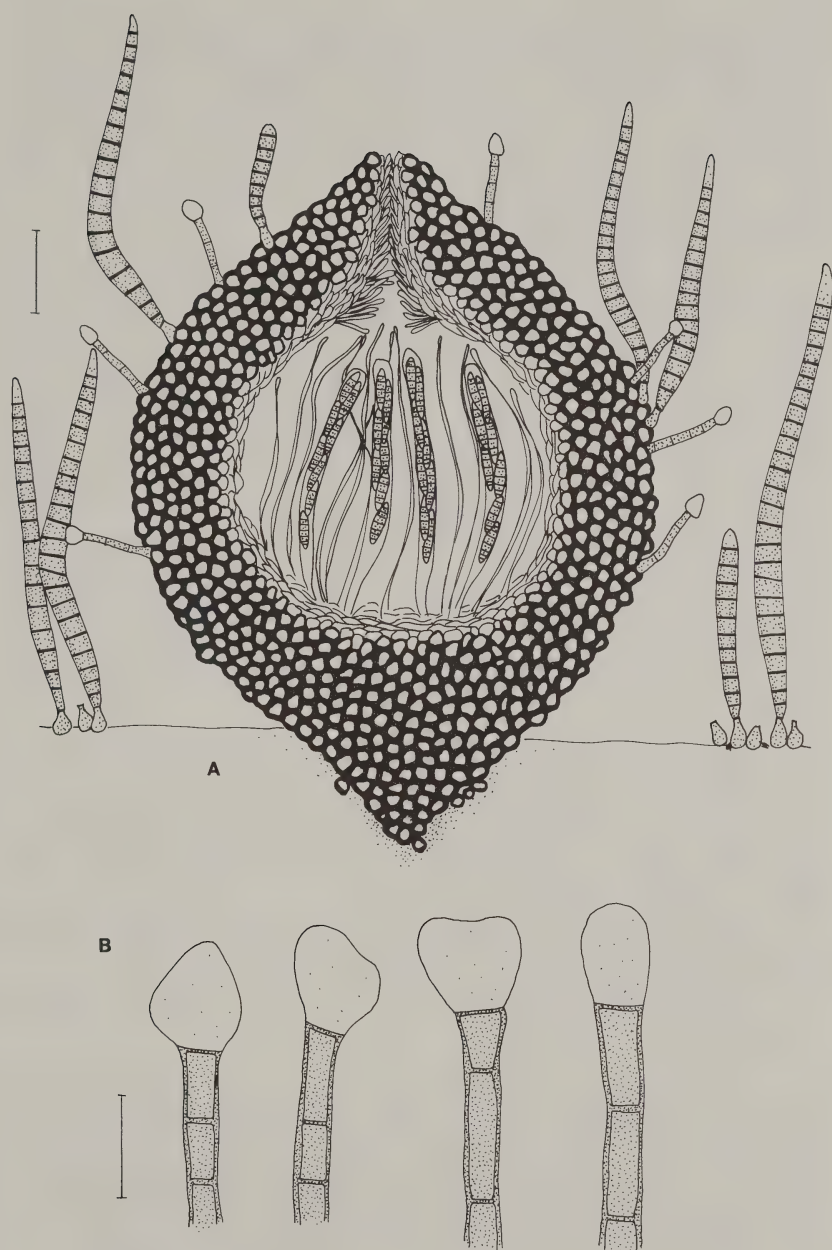


Fig. 9A-B. *Umbrinosphaeria caesariata*. - A. Median, longitudinal section of perithecium. - B. Perithecial setae. - A, B from DAOM 166653. - Scale bars: A = 50 μm , B = 10 μm .

(DAOM 166653 - isotype of *Sphaeria caesariata*). - AUSTRIA. St. Georgen, Sonntagsberg, on decayed wood of *Cerasus avium*, March 1919, P. Lambert (FH 3030 - holotype of *C. caespitulos*). - CANADA. Upper Brookside, Colchester Co., N.S., on decayed stump, 26 July 1929, L. E. Wehmeyer (DAOM 120170 - holotype of *C. multiseptata*). - CHINA. Anhwei, Huangshan, on decayed wood, 7 May 1935, S. Q. Deng 9268 (BPI 622085 - holotype of *C. caelestinoides*).

2) Additional material of *Umbrinosphaeria caesariata*. CANADA. Ontario, Ottawa, Moodie Drive, on wood chips on trail, 12 Sept. 1982, G. P. White (DAOM 183932 a&b). - *ibid.*, on conifer chips used for trails, 13 May 1984, G. P. White (DAOM 189168 a&b). - CZECH REPUBLIC. Moravia, Lanžhot, river-side virgin forest Raňšpurk, on wood of *Populus alba*, 5 Oct. 1977, Holubová-Jechová (PRM). - SLOVAK REPUBLIC. Central Slovakia, Malá Fatra Mts., the valley Vrátná Dolina, on decayed root of *Fagus sylvatica*, 28 Sept. 1983, Holubová-Jechová (PRM). - UKRAINE. Carpathian Mts., Massif Boržava, Pilipec, on wood of *Fagus sylvatica*, 25 June 1997, M. Réblová (Herb. M. Réblová 928/97, 929/97, 930/97). - Carpathian Mts., Kvasi near Rachiv, on the left bank of the river Tisa, on wood of *Fraxinus excelsior*, 28 June 1997, M. Réblová (Herb. M. Réblová 978/97). - Carpathian Mts., Luhy near Rachiv, valley above the spring, on decayed wood of *Acer pseudoplatanus*, 30 June 1997, M. Réblová (Herb. M. Réblová 961/97).

DESCRIPTIONS AND ILLUSTRATIONS. Shoemaker & White (1985: 278, Figs. 1-3, 7-13); Wehmeyer (1942: 576, Figs. 1, 2).

HABITAT. Saprobe on bark and decorticated wood of deciduous and coniferous trees. The teleomorph is always associated with the anamorph and usually occurs on hard wood, for instance on decorticated timbers, on chips or on railway sleepers.

KNOWN HOSTS. *Acer pseudoplatanus*, *Fagus sylvatica*, *Fraxinus excelsior*, *Populus alba*, and on an unidentified coniferous timber.

KNOWN DISTRIBUTION. The fungus is widespread in temperate Europe, North America and Asia.

Setae covering the perithecia (Fig. 11-13) disappear with increasing age; at first the amorphous globules at the top disappears and later the dark stipes, leaving the perithecia glabrous. Setae have been observed growing only over the perithecia together with the conidiophores. Simple setae have never been seen arising among the conidiophores on the substratum.

Of the four *Chaetosphaeria* species that are placed in synonymy of *U. caesariata*, type material of only *C. pezizaeformis* Schulzer could not be

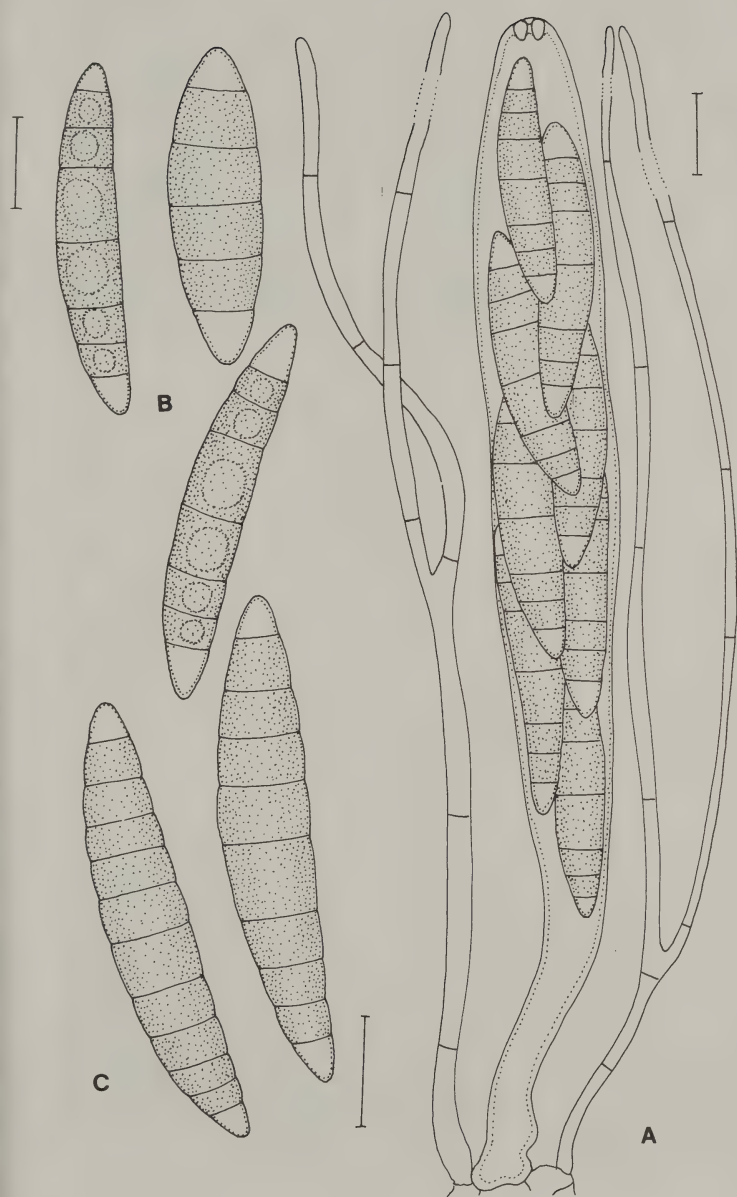


Fig. 10A-C. *Umbrinosphaeria caesariata*. - A. Asci, ascospores and paraphyses. - B-C. Ascospores. - A from DAOM 189168a; B from Herb. BPI 622085; C from DAOM 166653. - Scale bars: A-C = 10 μ m.

located. The synonymy is proposed on the basis of the original description and illustration.

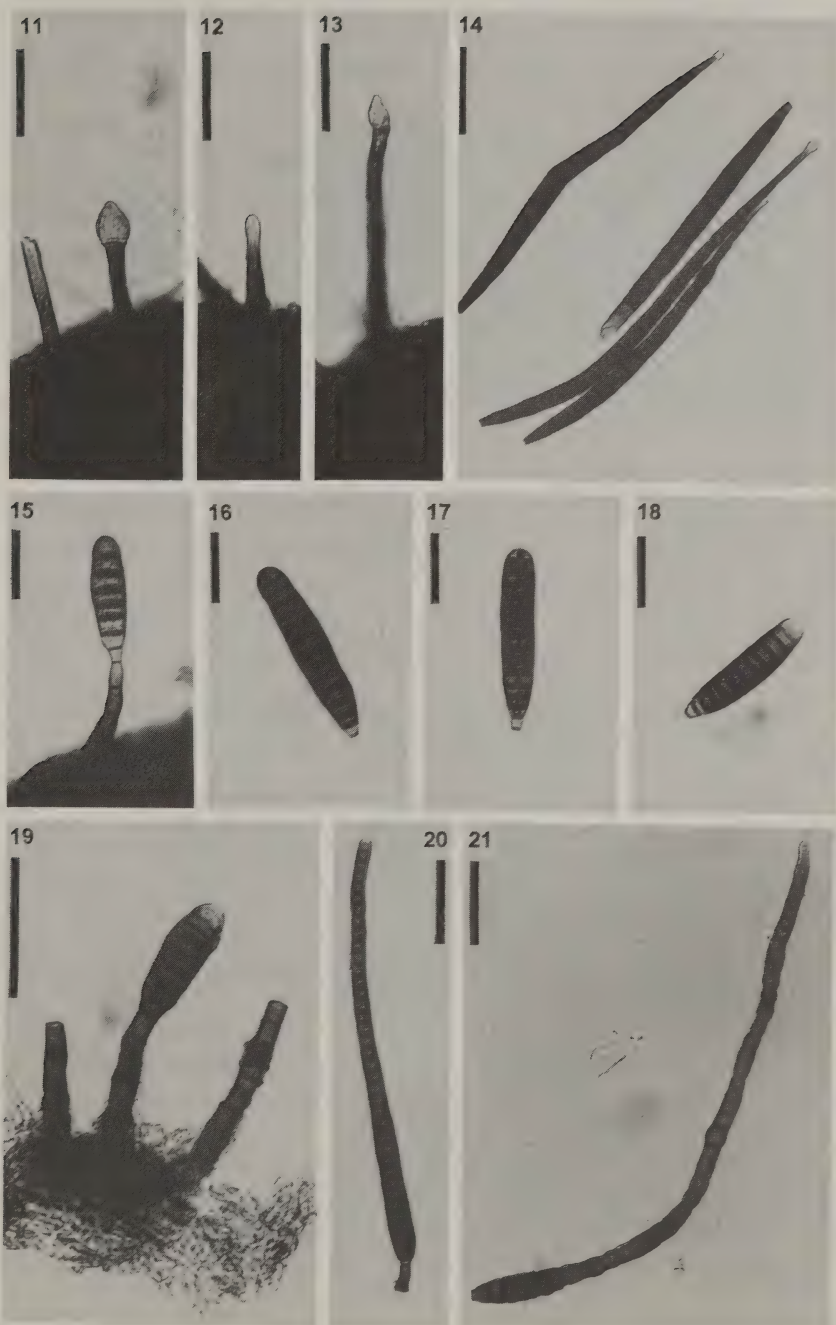
The anamorph has been fully described and well illustrated by Ellis (1958: 41, Figs. 26; 1976: 96, Fig. 67f) and Hughes & Illman (1974a: 1, 2). Ellis (1958, 1976) reported the fungus on dead wood of *Acer*, *Fagus* and *Quercus* from Europe (Great Britain) and North America (U.S.A.: New Jersey). Hughes & Illman (1974a) found it on decaying wood of *Alnus* and *Quercus* and other unidentified hardwood from Canada (British Columbia, Quebec). Farr & al. (1989) reported it from North America on wood of *Acer*. Matsushima (1971: 58, Fig. 94; Pl. 7-2) reported the fungus on the bark of a broad-leaved tree from the Solomon Islands.

Miyoshiella Kawamura, Jap. J. Bot. 4: 295, 1929.

The type material of *Miyoshiella fusispora* Kawamura, the type species of the genus, requested from the YAM and NICH herbaria (Japan) was not available. Although type material could not be examined, *M. fusispora* was well described and illustrated several times by Kawamura (1907, 1929) and Hino (1932, 1961), who based their observations on the type specimen (Fig. 22). Therefore, the name *Miyoshiella* Kawamura is accepted here for nonstromatic ascomycetous pyrenomycetes that have solitary to gregarious, superficial, globose to subglobose, ostiolate, papillate, glabrous perithecia; periphysate ostiolar canal; a firm peridium consisting of two layers, the outer layer of thick-walled, dark brown angular cells with opaque walls; a hamathecium of persistent, cylindrical, septate paraphyses; unitunicate asci with a distinct, refractive, J- apical annulus; fusiform, 3-septate, hyaline ascospores and an anamorph with holoblastic conidiogenesis that belongs to *Sporidesmium*.

TYPE SPECIES. *Miyoshiella fusispora* Kawamura, Jap. J. Bot. 4: 296, 1929.

Figs. 11-21. 11-14. *Umbrinosphaeria caesariata*. 15-18. *Sporidesmium larvatum* anamorph of *Miyoshiella larvata*. 19-21. *Sporidesmium adscendens* anamorph of *Miyoshiella triseptata*. - 11-13. Perithecial setae. - 14. *Sporidesmium hormiscioides* anamorph, conidia from nature. 15. Conidiophore and young conidium, from nature. - 16-18. conidia, from nature. - 19. Conidiophore and young conidium, from nature. - 20-21. Mature conidia, from nature. - Figs. 11-21: BF. - Figs. 11-13 from DAOM 166653; 14 from Herb. M. Réblová 930/97; 15 from Herb. M. Réblová 978/97; 16-18 from PRM 842976; 19, 20 from B 87656; 21 from DAOM 151144. - Scale bars: 11-18 = 50 μ m, 19-21 = 50 μ m



ANAMORPHS. *Sporidesmium* Link, Mag. Ges. Nat. Freunde 3: 41, 1809.

SYSTEMATIC POSITION. Trichosphaeriaceae G. Winter, Trichosphaeriales M.E. Barr

ACCEPTED TAXA. *Miyoshiella fusispora* Kawamura, *M. larvata* Réblová, *M. triseptata* (Shoemaker & White) Réblová

HABITAT. Saprobies on bark and hard decorticated wood of coniferous and deciduous trees.

KNOWN DISTRIBUTION. Probably widespread in temperate Europe (Czech Republic, France, Hungary, Slovak Republic, Ukraine) and Asia (Japan). The genus has not been reported from North America.

Key to species of *Miyoshiella*

1. Ascospores up to 25 μ m long
- 2
1. Ascospores more than 25 μ m long; occurring on bamboo culms; *Sporidesmium bambusicola* anamorph *M. fusispora*
 2. Occurring on wood and bark of coniferous trees; *Sporidesmium larvatum* anamorph *M. larvata*
 2. Occurring on wood and bark of deciduous tree; *Sporidesmium adscendens* anamorph *M. triseptata*
1. ***Miyoshiella fusispora*** Kawamura, Jap. J. Bot. 4: 296, 1929. Fig. 22.
 - $\equiv$ *Miyoshia fusispora* Kawamura, J. Coll. Sci. Imp. Univ. Tokyo 23: 6, 1907. (Illegitimate. Art. 53.1.)
 - $\equiv$ *Chaetosphaeria fusispora* (Kawamura) Hino, Bull. Miyazaki Coll. Agr. For. 4: 191, 1932. [non *Chaetosphaeria fusispora* P. Larsen, Dansk. Bot. Arkiv 14: 7, 1952, nec *Chaetosphaeria fusispora* W. Gams & Hol.-Jech., Stud. Mycol. 13: 45, 1976.]

ANAMORPH. ***Sporidesmium bambusicola*** M.B. Ellis, Mycol. Pap. 70: 34, 1958.

DESCRIPTIONS AND ILLUSTRATIONS. Kawamura (1907: Pl. 3, Figs. 1-7; 1929: 296); Hino (1932: 191, Fig. 1; 1961: 127, Fig. 34).

HABITAT. Saprobe on bamboo culms.

KNOWN HOST. *Phyllostachys aurea*, *P. bambusoides*, *Pleioblastus simoni*, *Semiarundinaria fastuosa*, *S. yashadake*, *Sinobambusa tootsik*.

KNOWN DISTRIBUTION. The only reliable report of the teleomorph is from Japan (Kawamura, 1907; Hino, 1932, 1961).

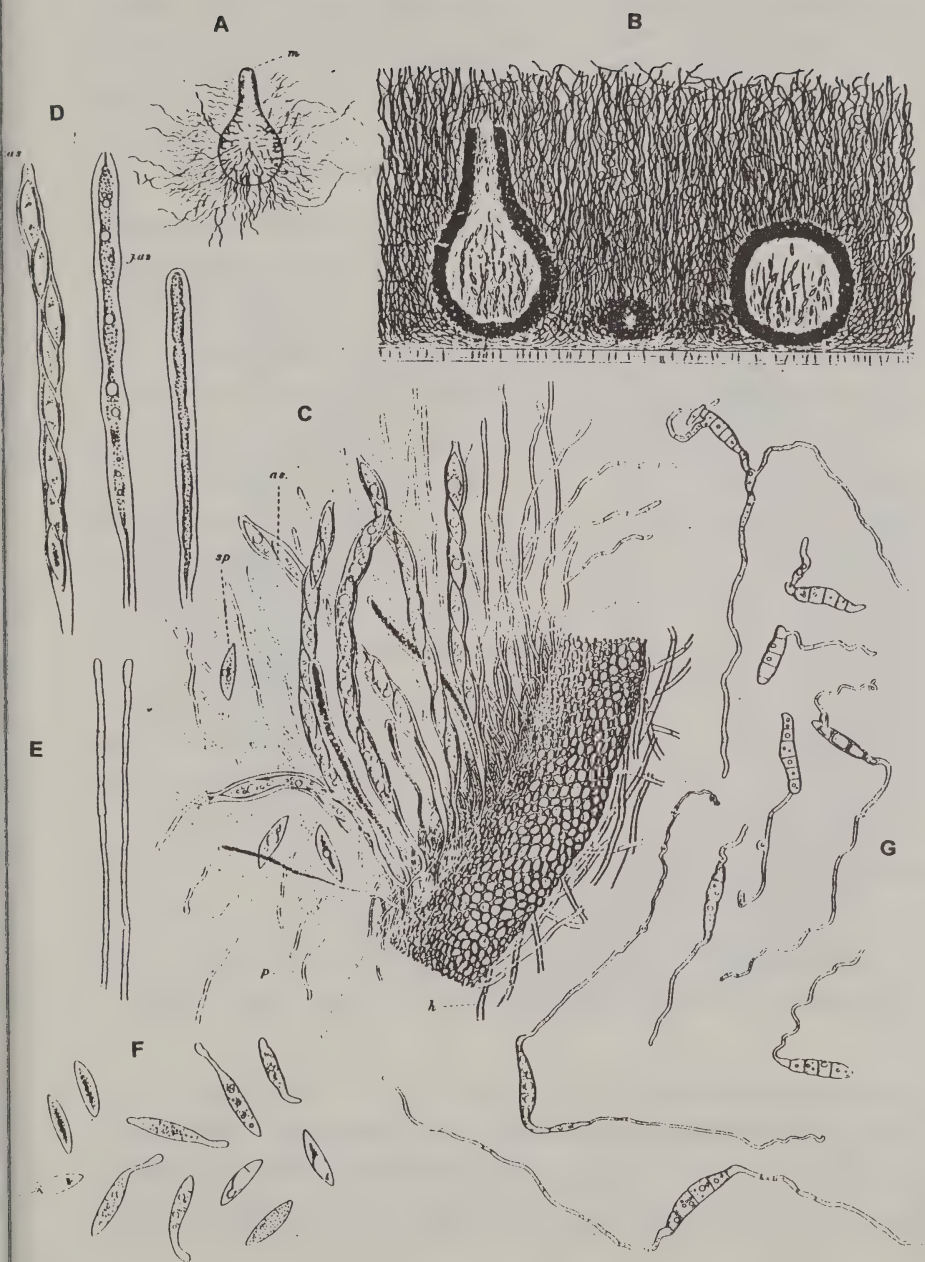


fig. 22A-G. *Miyoshiella fusicapna*. - A. Perithecial. - B. Habit sketch of erithelia seated on the substratum among conidiophores. - C. Cross section of the perithecial wall. - D. Mature (left) and young (right) asci. - E. Paraphyses. - F. Ascospores. - G. Germinating ascospores. (from the holotype, according to Sawamura, 1907).

Kawamura (1907) described the genus *Miyoshia* Kawamura to accommodate his new fungus *Miyoshia fusispora* Kawamura but he created an illegitimate later homonym of the plant name *Miyoshia* Makino, now a synonym of *Petroseria* Makino. Kawamura (1929) introduced the name *Miyoshiella* for *Miyoshia fusispora* and based *Miyoshiella fusispora* Kawamura on the illegitimate basionym *Miyoshia fusispora*. He adopted the epithet „*fusispora*“ and treated the resultant combination as a new one. Hino (1932) re-examined the type collection of this fungus and included it in *Chaetosphaeria* Tul. & C. Tul.

Based on the descriptions and detailed illustrations provided by Kawamura (1907) and Hino (1932) the correct place for this fungus seems to be in *Miyoshiella*, in owing to the 3-septate, hyaline, fusiform ascospores; cylindrical asci with a pronounced apical annulus; persistent paraphyses; peridium that comprises thick-walled, dark brown, angular cells and the associated anamorph which, according to the illustration and description, is *Sporidesmium bambusicola* (Ellis 1976).

Kawamura (1907) described hairy, black, pyriform perithecia 250-350 μm wide and 500-600 μm high; 1-celled, hyaline ascospores $28-33 \times 6-8 \mu\text{m}$; filiform paraphyses; cylindrical asci with a spherical space at the top and conidia $50-120 \times 5-15 \mu\text{m}$. Hino (1932) gave the following description of the type material: „Ascomata superficial, pyriform, black, carbonaceous, setose, 369-567 μm wide and 400-816 μm high; 8-spored, cylindric asci, obtuse at the apex, $123-200 \times 8-11 \mu\text{m}$; filiform, septate paraphyses, $126-198 \times 3.2-4.3 \mu\text{m}$; fusiform ascospores, when young 1-celled and hyaline, 1-3-septate and often subhyaline at maturity, $26-43 \times 6-10 \mu\text{m}$. Conidia erect, straight or curved, with 1-38 pseudosepta, $6-191 \times 4-15 \mu\text{m}$ “. The apical annulus was observed by both Kawamura (1907) and Hino (1932) and recognized as a marked characteristic of this species, described as a spherical space at the top of the ascus and illustrated as two clearly visible, relatively large bodies just beneath the ascus apex.

The anamorph was fully described and well illustrated by Ellis (1958: 34, Fig. 20; 1976: 81, Fig. 60a). It is reported on dead culms of *Bambusa* from Ghana, Sierra Leone and Togoland. Kawamura (1907, 1929) and Hino (1932) reported this fungus from Japan as cause of black spots on bamboo culms.

2. *Miyoshiella larvata* Réblová, sp. nov. Figs. 15-18, 23, 24.

Perithecia superficialia, subglobosa, cum papilla minuta, 120-180 μm lata, 130-180 μm alta, glabra, pariete bistratoso, ostiolo periphysato. Paraphyses persistentes, copiosae, septatae, cylindratae. Asci unitunicati, 8-sporei, cylindrato-clavati, apice non amyloideo, annulo refractivo, 69-70 $\times$

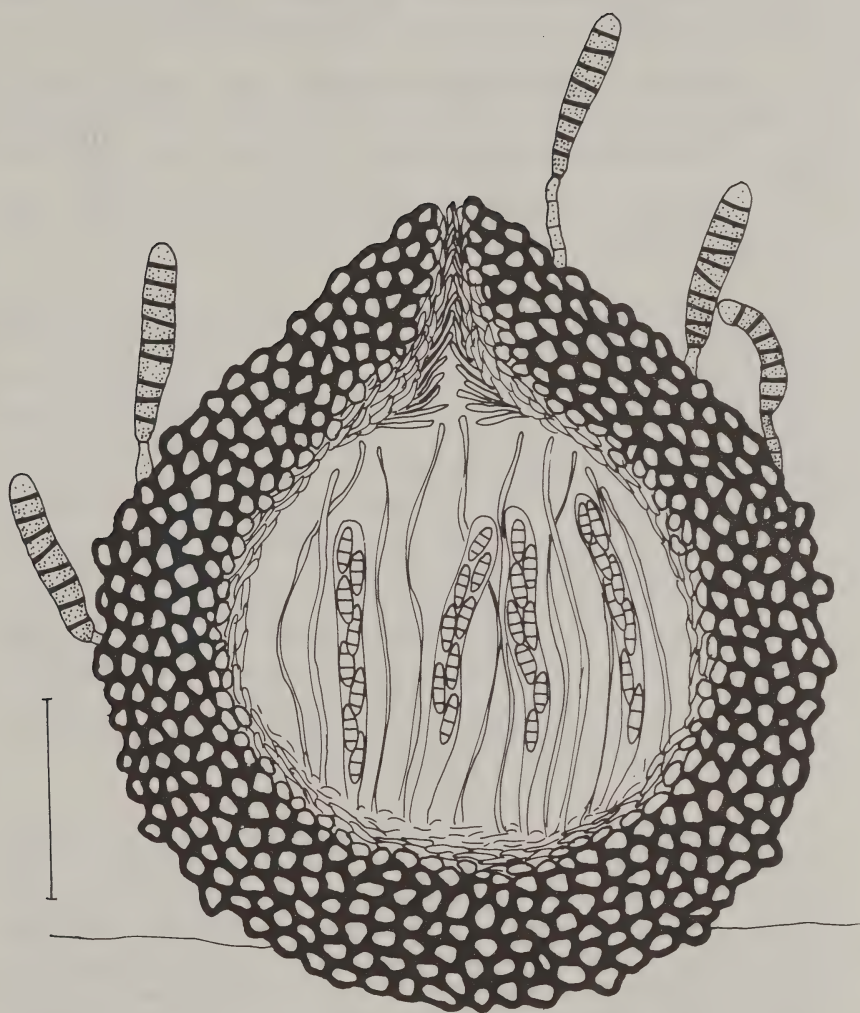


Fig. 23. *Miyoshiella larvata*. - Median, longitudinal section of perithecium. - From PRM 842976. - Scale bar = 50 μ m.

9-10.5 μm . Ascospores 2-3-stichae, fusiformes, 3-septatae, hyalinae, 21-25 $\times$ 4-4.5 μm .

Holotypus: Slovakia orientalis, Mt. Rudník, in ligno putrido *Abietis albae*, 17 Aug. 1972, leg. V. Holubová-Jechová, PRM 842976.

ANAMORPH. ***Sporidesmium larvatum*** Cooke & Ellis, Grevillea 6: 86, 1878. Figs. 15-18.

$\equiv$ *Clasterosporium larvatum* (Cooke & Ellis) Sacc., Syll. Fung. 4: 385, 1886.

$\equiv$ *Stanjehughesia larvata* (Cooke & Ellis) Subram., Proc. Indian. Natn. Acad. Sci., Ser. B58, 4: 184, 1992.

Perithecia superficial, solitary to gregarious, subglobose, slightly flattened at the base, minutely papillate, 120-180 μm wide and 130-180 μm high, ostiolate, glabrous, slightly roughened, often sparsely covered by the conidiophores of the anamorph.—Peridium firm, consisting of two layers. Outer layer 25-40 μm wide, comprising cells thick-walled, dark brown, on the exterior surface heavily pigmented angular cells; inner layer 4-6 μm wide, of subhyaline to hyaline, elongated, compressed cells arranged in 1-3 layers.—Ostiolar canal periphysate.—Paraphyses persistent, abundant among the asci and extending beyond them, septate, slightly constricted, cylindrical, apically free, 3-5 μm wide.—Asci unitunicate, 8-spored, 67-70 $\times$ 9.5-10.5 μm , cylindrical-clavate, short stipitate, broadly rounded at the top, apex with a shallow, J-, refractive apical annulus.—Ascospores fusiform, straight or inequilateral, 21-25 $\times$ 4-4.5 μm , 3-septate, hyaline, septa developing in the sequence 2:1:2, not constricted at the septa, each cell with a large oil drop, 2-3-seriate in the ascus with ends partially overlapping.

CHARACTERISTICS IN CULTURE. Colonies on PCA slow growing, reaching 4 mm diameter in 10 days at 25° C in darkness, colonies cultivated for another 10 days at 25° C in cool white fluorescent light reaching 5-6 mm diameter. Colonies velvety, grey, umbonate, margins fimbriate, reverse dark grey; copious conidial production. On MEA, CMA and OA colonies have a similar appearance and sporulated copiously in 20 days.—Aerial mycelium well developed; mycelium immersed, hyphae 2-3.5 μm wide, branched, septate, subhyaline, smooth.—Conidiophores arising from the hyphae of substrate mycelium, widespread over the colony semi-macronematous, reduced to the conidiogenous cells.—Conidiogenous cells monoblastic, integrated, ampulliform, arising directly, terminally or laterally, from the hyphae of substrate mycelium, 0-1-septate, hyaline, 6-12.5 $\times$ 5-6 μm .—Conidia holoblastic, straight or curved, cylindrical to fusiform or slightly

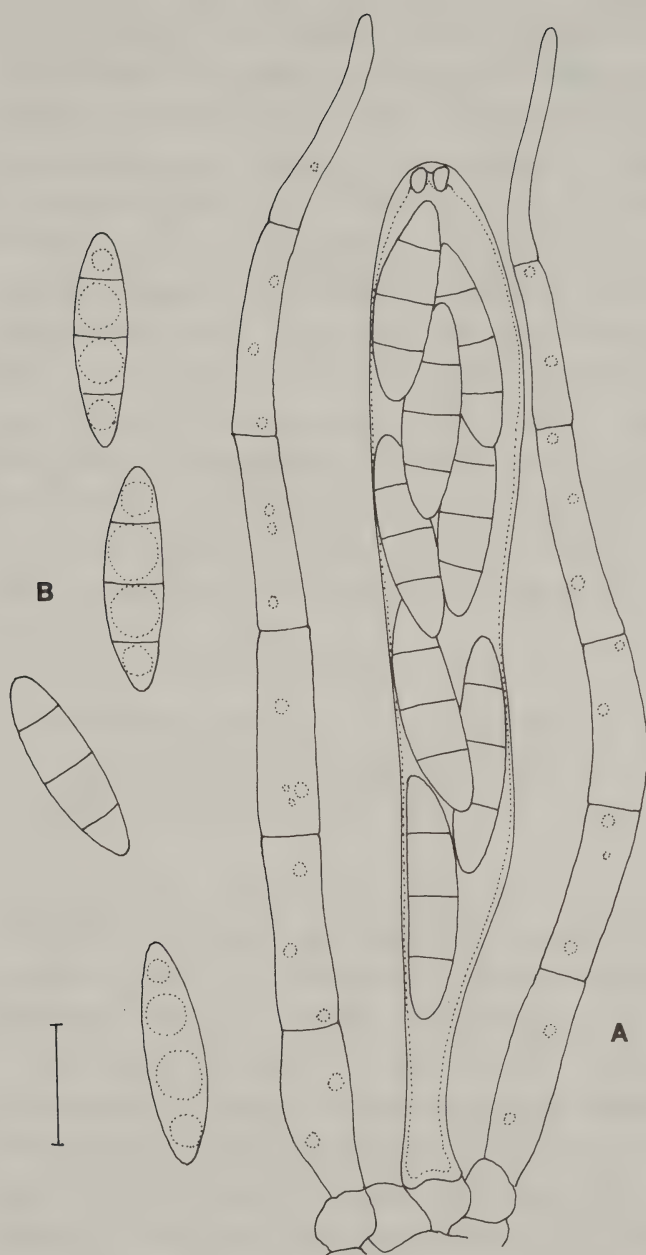


Fig. 24A, B. *Miyoshiella larvata*. - A. Asci, ascospores and paraphyses. - B. Ascospores. - A, B from PRM 842976. - Scale bars: A, B = 10 μ m.

clavate, rounded at the distal end, tapering to the proximal end, truncate and 3-4.5 μm wide at the base, mid to dark brown, darker brown at the septa, 5-9-septate, slightly constricted, 27-47 μm long and 7-9 μm wide in the middle, conidial masses dark grey to nearly black. Conidium secession schizolytic.

MATERIAL EXAMINED. 1) Type material. SLOVAK REPUBLIC. Eastern Slovakia, on the slopes of Mt. Rudník, Branisko near Spišské Podhradie, on decayed wood of *Abies alba*, 17 Aug. 1972, V. Holubová-Jechová (PRM 842976 - holotype of *Miyoshiella larvata*).

2) Additional material of *Miyoshiella larvata*. CZECH REPUBLIC. Southern Bohemia, Šumava Mts., glacial cirque of the lake Černé jezero near Železná Ruda, on decayed wood of *Abies alba*, 22 Oct. 1996, M. Réblová (Herb. M. Réblová 897/96).

3) Material of *Sporidesmium larvatum* examined. CZECH REPUBLIC. Southern Bohemia, Šumava Mts., glacial cirque of the lake Černé jezero near Železná Ruda, on decayed wood of *Picea abies*, 26 Aug. 1997, M. Réblová (Herb. M. Réblová 1045/97, 1046/97). - Southern Bohemia, Novohradské hory Mts., virgin forest Žofínský prales near Pivonice, on decayed wood of *Abies alba*, 19 July 1995, M. Réblová (Herb. M. Réblová 750/95).

HABITAT. Saprobe on hard, decayed wood and bark of a coniferous tree.

KNOWN HOST. *Abies alba*.

KNOWN DISTRIBUTION. The teleomorph is known only from the Czech and Slovak Republics, but the anamorph is known from Europe, the Indian subcontinent and New Zealand. No other information found in the literature.

The ascospores of *Miyoshiella larvata* are much like those of *M. triseptata* in the length and shape but both fungi are distinct in all other respects and associated anamorph. Ascospores of *M. larvata* are narrower, the asci smaller and narrower, paraphyses wider and slightly constricted at the septa and the perithecia are smaller in contrast to those of *Miyoshiella triseptata*.

The anamorph was fully described and illustrated by Ellis (1958: 38, Fig. 23; 1976: 82, Fig. 60f) and Hughes & Illman (1974b: 1-2). Ellis (1958) reported it from rails of cedarwood and on wood of *Abies alba* and *Taxus baccata* from Canada, Great Britain, Pakistan and U.S.A. Hughes & Illman (1974b) mentioned the frequent occurrence of *Sporidesmium larvatum* on worked wood of various kinds of coniferous trees, e.g. *Abies balsamea*, *Pinus strobus*, *Thuja occidentalis* from Canada (Manitoba, Ontario, Quebec) and

U.S.A. (California, New Jersey, New York). Hughes (1978) reported the fungus on worked wood of conifer from New Zealand. Matsushima (1975: 138, Pl. 120-3; 133-3) reported the fungus on bark of broad-leaved tree from Japan. Another three collections were made in the Czech and Slovak Republics where the fungus occurs rarely on the bark and decayed wood of *Abies alba* forming dark, hairy colonies or growing over the perithecia.

Subramanian (1992) transferred *Sporidesmium larvatum* to his new genus *Stanjehughesia* that he characterized by the absence of conidiophores and the formation of conidia that are euseptate are produced directly on simple conidiogenous cells. However, I have found macronematous conidiophores growing in nature, covering the perithecia of the teleomorph (Fig. 21) as well as growing on the surface of the substratum, they are several-celled and lack any visible percurrent proliferation. Conidiophores growing in culture were semi-macronematous, reduced to single 0-1-septate conidiogenous cells. The character of conidiophores in *S. larvata* is variable if growing under different conditions. Hughes & Illman (1974b) similarly characterized the conidiophores of *Sporidesmium larvatum* from nature when they described them as several-septate, ampulliform or obclavate, occasionally with the terminal conidiogenous cell proliferated through the scar to form another conidium.

3. ***Miyoshiella triseptata*** (Shoemaker & White) Réblová, comb. nov.

Figs. 19-21.

≡ *Lasiosphaeria triseptata* Shoemaker & White, Sydowia 38: 282, 1985.

- basionym.

ANAMORPH. ***Sporidesmium adscendens*** Berk., Ann. Nat. Hist.

4: 291, 1840.

Figs. 19-21.

≡ *Clasterosporium adscendens* (Berk.) Sacc., Syll. Fung. 4: 394, 1886.

≡ *Ellisembia adscendens* (Berk.) Subram., Proc. Indian. Natn. Acad. Sci., Ser. B58, 4: 183, 1992.

MATERIAL EXAMINED. 1) Type material. HUNGARY. Vácraót, Botanical garden, on bark of *Platanus orientalis*, 10 June 1956, S. Tóth (DAOM 151144 - holotype of *Lasiosphaeria triseptata*).

2) Material of *Sporidesmium adscendens* examined. HUNGARY. Mt. Bakonyhegység, Hubertlak near Bakonybél, on decayed wood of *Fagus sylvatica*, 17 Dec. 1975, S. Tóth (BP 78152). - Börzsöny-heség Mts., valley of the Morgó-patak Brook near Kismaros, on decayed wood, 13 Sept. 1990,

Á. Révay (BP 87656). - Comit. Zala, near Bak, on decayed wood, 2 Oct. 1987, J. Gönczöl (BP 87657).

DESCRIPTIONS AND ILLUSTRATIONS. Shoemaker & White (1985: 282, Fig. 15).

HABITAT. Saprobe on woody substrata.

KNOWN HOST. *Platanus orientalis*.

KNOWN DISTRIBUTION. Europe: Hungary. The teleomorph is known only from the type collection. There are no other reports in the literature.

Miyoshiella triseptata resembles *M. larvata* in ascospore morphology but differs in all other respects and in the *Sporidesmium adscendens* anamorph.

The anamorph occurs more frequently than the teleomorph, forming dark, effuse, hairy colonies. I have examined several collections made in the Czech Republic and Hungary but in no case was the teleomorph associated. *S. adscendens* was fully described and illustrated by Ellis (1958: 32, Fig. 19; 1971: 119, Fig. 77d) and reported on wood of *Buxus*, *Carpodinus*, *Cassia*, *Elaeis*, *Heeria*, *Hippocratea*, *Nauclea*, *Nyssa*, *Quercus*, *Uapaca* and *Vangueria* from Europe, Falkland Islands, Sierra Leone, Tanzania and Zambia. Matsushima (1975: 135, Pl. 120-1, 133-4; 1980: 68) mentioned it on bark of *Quercus* sp. from Japan and on bark of *Casuarina equisetifolia* from Taiwan. McKenzie (1995: 10, Fig. 1) reported the fungus on Pandanaceae from Hawaii, Malaysia and Hong Kong. Sutton (1993) listed the fungus occurring on a dead lian and wood from Malawi with references to other reliable reports.

DISCUSSION

The characters such as conidial septation and conidiophore proliferation that were used by Subramanian (1992) and Hernández-Gutiérrez & Sutton (1997) in separating 11 genera from *Sporidesmium* sensu lato, however, have diagnostic value but are not necessarily phylogenetically informative. Subramanian entirely based his work on data from the literature and did not add no observations of the material. The delimitation of these genera is schematic and they apparently do not represent natural units. If the Subramanian's concept is followed, the *Sporidesmium* species associated with their teleomorphs would fall in two genera *Stanjehughesia* and *Ellisembia*, distinguishable by conidial septation and conidiophore proliferation, but these characters are not always correlated. For instance, although *Stanjehughesia* was separated from *Sporidesmium* by lack of conidiophores, nevertheless the conidiophores of *Sporidesmium larvatum* (as *Stanjehughesia larvata*; Subramanian, 1992) growing in nature are

macronematous, occasionally proliferated, erect and several septate; while growing in culture they are semi-macronematous, reduced to the single conidiogenous cells and not proliferated.

Conidial septation was considered as one of the main diagnostic features in separating *Sporidesmium* sensu lato (Subramanian, 1992; Hernández-Gutiérrez & Sutton, 1997). Luttrell (1963) recognized two major groups of multicellular conidia that he referred to as euseptate and distoseptate. Cole & Samson (1979) based their concept of wall differentiation of euseptate and distoseptate conidia on an electron microscopic study of *Spegazzinia tessartha* (Berk. & Curt.) Sacc. (euseptate) and *Drechslera sorokiniana* (Sacc.) Subram. & Jain (distoseptate). In their interpretation of distoseptation: „the initial stages of differentiation are the same as those of euseptate conidia; the conidia have two wall layers when the septa are initiated and only the inner wall layer is continuous with the developing septum. The distinction is demonstrated later, during maturation. “ In both euseptate and distoseptate conidia gradually separate from each other but in euseptate conidia the outer wall layer breaks down while in distoseptate conidia it remains intact. Thus, a septum develops in both euseptate and distoseptate conidia, but it is difficult to see in the later.

According to Subramanian's concept (Subramanian, 1992) of *Sporidesmium*, *Umbrinosphaeria* would have a *Stanjehughesia* anamorph and *Miyoshiella* would have two anamorph genera, *Stanjehughesia* and *Ellisembia*, but the teleomorphs are not distinct from each other. The fact that species of both *Umbrinosphaeria* and *Miyoshiella* have anamorphs that could be placed in *Stanjehughesia* or *Ellisembia*, is an argument that the characters used to distinguish them from *Sporidesmium* are not phylogenetically significant. *Sporidesmium* is accepted here as an anamorph of both *Umbrinosphaeria* and *Miyoshiella*.

Carmichael & al. (1980) mentioned three teleomorph genera that are associated with *Sporidesmium* anamorphs, viz. *Placosoma* H. Sydow, *Akaropeltella* Farr and *Eupelte* H. Sydow.; all of them are members of the Dothideales Lindau. Hughes (1978) observed associated conidiophores and conidia in natural material of *Placosoma nothopanacis* H. Sydow, the type of the genus, which he did not identify as belonging to any anamorph, but he noted them only to be generically similar to those described in *Eupelte rapanea* Hansford. *Eupelte* has a *Septoideum*- or *Clasterosporium*-like anamorph (Arx & Müller, 1975). The anamorph of *Akaropeltella* Farr (= *Stomiopeltis* Theiss., Arx & Müller, 1975) is debatable. Farr (1972) described two hyphomycetes accompanying the ascomata of *Akaropeltella kielmeyerae* (Bat. & Bez.) Farr, viz. *Sporidesmium kielmeyerae* Farr, and *Septonema*

kielmeyerae Farr and noted that they apparently occur independently of the ascomata. Arx & Müller (1975) came to the same conclusion. According to them the setae and conidia described by Farr (1972) may belong to another accompanying fungus. It is obvious that *Sporidesmium* sensu lato (Ellis, 1958, 1971, 1976) is not related to the anamorphs of any of the genera with bitunicate asci mentioned above. It is possible that some species of *Sporidesmium* sensu lato could be mistakenly identified as species of *Clasterosporium*, despite the fact that both are clearly distinct in morphology of the mycelium. Ellis (1958) distinguished both *Clasterosporium* Schw. and *Sporidesmium* sensu lato on the basis of the presence of hyphopodia on the mycelium; the former has hyphopodiate hyphae and the hyphae of latter lack hyphopodia. Ellis (1958) reported the *Clasterosporium* anamorph for *Asterodothis solaris* (Kalchbrenner & Cooke) Theiss., *Asterina clasterosporium* S. Hughes and *Balladynopsis crossopterygis* Deighton & M.B. Ellis. Arx & Müller (1975) mentioned both, the celomycete *Asterostromina* Batista & Vital and the hyphomycete *Clasterosporium*-like, the latter in brackets, as the anamorph of *Asterodothis* Theiss., a member of the Dothideales.

Umbrinosphaeria and *Miyoshiella* have apparently no affinity to *Chaetosphaeria* (e.g. Hino, 1932, 1961; Wehmeyer 1942) or *Lasiosphaeria* (Saccardo 1883; Shoemaker & White 1985), where the type and other species were previously included. On the basis of the anatomy of the perithecial wall *Umbrinosphaeria* and *Miyoshiella* are closely related to *Iodosphaeria*, with *Ceratosporium* and *Selenosporella* synanamorphs, and *Phaeotrichosphaeria*, with *Endophragmiella* anamorphs. The two latter teleomorph genera were previously included in the Lasiosphaeriaceae Nannf. (Barr, 1990) but on the basis of the characters of perithecial wall, asci, ascospores and a conidiogenesis of the anamorphs, they should be separated from the core genera of the Lasiosphaericaeaceae, viz. *Lasiosphaeria*, *Cercophora* Fuckel, *Bombardia* (Fr.) P. Karst. and *Eosphaeria* Höhnelt (Réblová & al, 1999). Members of the Lasiosphaeriaceae are distinct in having leathery, only partly carbonaceous peridium that comprises thin-walled, light brown, angular to brick-like cell; the presence of a subapical chamber and plasmatic globule in the ascus apex; a J- apical annulus; ascospores that are cylindrical, bent in the lower third, sometimes inflated and partly darkly pigmented in the upper part and that germinate by phialides and germ tubes; anamorphs with exclusively enteroblastic-phialidic conidiogenesis (Gams & Holubová-Jechová, 1976; Petrini & al. 1984; Mouchacca & Gams, 1993). In *Iodosphaeria* (Samuels & al., 1987), *Phaeotrichosphaeria* (Sivanesan, 1983) as well as in *Umbrinosphaeria* and *Miyoshiella* the anatomy of peridium is entirely different. The peridium

comprises thick-walled, dark brown, opaque angular cells; asci lack the subapical chamber and plasmatic globule; the apical annulus may be J+ and ascospores are ellipsoidal to fusiform, germinating by germ tubes. Conidiogenesis of the *Endophragmiella* anamorph of *Phaeotrichosphaeria* is holoblastic; conidial secession is rhexolytic and the fracture of the wall of the subtending cell results in a more or less conspicuous frill around the conidium scar (Hughes, 1979). Conidiogenesis of the *Ceratosporium* and *Selenosporella* synanamorphs of *Iodosphaeria* is holoblastic; the conidiogenous cells of *Selenosporella* are sympodially proliferated and denticulate. Conidium secession of both anamorphs is schizolytic. Conidiogenesis of the *Sporidesmium* anamorph of *Umbrinosphaeria* and *Miyoshiella* is holoblastic and conidium secession is schizolytic. *Phaeotrichosphaeria*, *Iodosphaeria*, *Miyoshiella* and *Umbrinosphaeria* form a group of closely related species to which may also belong *Lasiosphaeria canescens* (Pers.: Fr.) P. Karst. and *Lasiosphaeria punctata* Munk, both with *Endophragmiella* and *Selenosporella* synanamorphs and the peridium anatomy similar to *Iodosphaeria* and *Phaeotrichosphaeria*. Perithecia and perithecial wall of *Setocampanula* Sivan. & Hsieh (Sivanesan & Hsieh, 1987), of the Trichosphaeriaceae, are anatomically similar to those of *Iodosphaeria* and *Phaeotrichosphaeria*. Perithecia are nonpapillate, densely clothed, except for the flat top, by long flexuous hairs; the peridium comprises thick-walled, angular cells. The mature perithecia have a peculiar appearance, becoming bell-shaped, a character that was seen in the median, longitudinal sections (Sivanesan & Hsieh, 1987). This appearance is unusual among other pyrenomycetous ascomycetes. Ascospores are hyaline, 2-celled and the anamorph is unknown.

The genus *Selenosporella* has previously been reported as a synanamorph of several hyphomycetous genera such as *Arachnophora* Hennebert, *Ceratosporium*, *Endophragmiella*, *Sporidesmium* and *Teratosperma* H. Sydow. *Teratosperma* is similar to *Endophragmiella* in that conidiogenous cells of both proliferate percurrently after the rhexolytic secession of conidia. *Teratosperma* includes the following species that are associated with a *Selenosporella* synanamorph, viz. *T. anacardii* Hansf. (as *Podoconis*, Hughes, 1952), *T. cornigerum* (Ell. & Everh.) M.B. Ellis, *T. subulatum* (Cooke & Ellis) S. Hughes, *T. sclerotivora* (Uecker, Ayers & Adams) S. Hughes (Uecker & al., 1978; Hughes, 1979). *Arachnophora* Hennebert is a morphologically similar genus, conidia of *Arachnophora excentrica* (B. Sutton) S. Hughes (Hughes, 1979) germinate directly by *Selenosporella* conidia and conidiogenous cells. *Laterispora brevirama* Uecker, Ayers & Adams, which has a *Selenosporella* synanamorph (Uecker & al., 1982), was described to be parasitic on sclerotia of *Sclerotinia minor*

Jagger. The conidiophores and conidia of *L. brevirama* are much like those of *Teratosperma uniappendiculata* Matsushima but differ in size, and could be interpreted as a *Teratosperma*. Moreover, the *Endophragmiella* anamorphs of *Lasiosphaeria canescens* and *L. punctata* and several other species of *Endophragmiella* have been reported to have *Selenosporella* synnamorph, viz. *E. africana* P.M. Kirk (Kirk, 1982), *E. canadensis* (Ell. & Everh.) B. Sutton (Matsushima, 1975), *E. dimorphospora* (Awao & Udagawa) S. Hughes (Awao & Udagawa, 1974) and *E. theobromae* M.B. Ellis (Hughes, 1979). Matsushima (1987) observed *Sporidesmium tropicale* M.B. Ellis, on material from Cuba, to have a *Selenosporella* synanamorph.

The anamorph genera *Endophragmiella*, *Teratosperma*, *Arachnophora*, *Ceratosporium* and *Sporidesmium*, all of them with *Selenosporella* synanamorphs, form a group of related taxa. The kind of conidium secession that is rhexolytic in *Endophragmiella*, *Teratosperma* and *Arachnophora* and schizolytic in *Ceratosporium* and *Sporidesmium*, is a useful character that is taxonomically significant (Hughes, 1979). Of these taxa *Endophragmiella*, *Ceratosporium*, *Selenosporella* and *Sporidesmium* are associated with a group of teleomorphs that are presumably closely related because they have similar peridium, ascus and ascospore anatomy and conidiogenesis. On the basis of those characters the teleomorph genera *Iodosphaeria*, *Phaeotrichosphaeria*, *Umbrinosphaeria* and *Miyoshiella* represent a group of related taxa and are placed in the Trichosphaeriaceae order Trichosphaeriales.

Umbrinosphaeria caesariata shares the characters of versicoloured ascospores with the two lignicolous genera of the Trichosphaeriaceae, viz. *Crassochaeta* Réblová and *Coniobrevicolla* Réblová, and with the two lignicolous or occasionally fungicolous genera of the Helminthosphaeriaceae Samuels, Candoussau & Magni, viz. *Tengiomyces* Réblová and *Chaetosphaerella* E. Müll. & C. Booth, respectively. *Crassochaeta* differs from *Umbrinosphaeria* in having setose perithecia, dark-brown, opaque, long and hyphoid or short and spine-like setae that never end in an amorphous globule; paraphyses cylindrical that are at the septa constricted; 3-septate ascospores and no known anamorph (Réblová, 1999c). *Coniobrevicolla* can be distinguished from *Umbrinosphaeria* by smaller, glabrous perithecia; indistinct apical annulus; 3-septate ascospores and unknown anamorph (Réblová, 1999b). *Chaetosphaerella* is distinct from *Umbrinosphaeria* in the obpyriform, stipitate, glabrous perithecia, from the base of which arise opaque, acute, spine-like setae; broadly cellular, deliquescent paraphyses; asci that lack any visible discharge mechanism in the apex; oblong, 3-septate ascospores and *Oedemium* Link and *Veramycina* Subram. synanamorphs. *Tengiomyces* differs from *Umbrinosphaeria* in having setose,

globose, nonpapillate, collapsing perithecia with a differentiated apex; broadly cellular, deliquescent paraphyses; asci that lack any visible discharge mechanism; ellipsoidal, 3-septate ascospores and a *Spadicoides* S. Hughes anamorph (Réblová, 1999a).

Umbrinosphaeria caesariata bears some resemblance to *Melanochaeta hemipsila* of the Chaetosphaeriaceae in the several-septate versicoloured ascospores, but ascospores of *M. hemipsila* are finally 5-septate, fusiform with broadly rounded ends, straight or curved. *M. hemipsila* is also distinct in the perithecial anatomy and in the *Sporoschisma* anamorph which has enteroblastic-phialidic conidiogenesis (Müller & al., 1968).

Owing to the morphology of the 3-septate, hyaline and fusiform ascospores, pronounced, refractive apical annulus, persistent paraphyses and glabrous perithecia species of *Miyoshiella* superficially resemble those of *Chaetosphaeria* of the Chaetosphaeriaceae. *Chaetosphaeria* is clearly distinguishable by the anatomy of the firm perithecial wall that comprises thin-walled, brown, opaque brick-like cells; asci arising in croziers; enteroblastic-phialidic conidiogenesis. *Miyoshiella larvata* and *M. triseptata* somewhat resemble *Chaetosphaeria ovoidea* (Fr.) Constant., K. Holm & L. Holm and *C. pulviscula* (Currey) C. Booth but they are distinct in peridium anatomy and conidiogenesis, both of which argue for placement of *Miyoshiella* with *Umbrinosphaeria* in the Trichosphaeriaceae rather than in Chaetosphaeriaceae.

Chaetosphaeria ampulliformis Sivan. & Chang, with *Hemicorynespora multiseptata* Sivan. & Chang anamorph was described from wood of an angiospermous plant from Taiwan (Sivanesan & Chang, 1997). The type of *C. ampulliformis* was not examined by me. Although it superficially resembles *Miyoshiella* in having septate, hyaline to pale brown ascospores and a similar anamorph it is distinct in other respects such as a thin peridium (up to 16 µm wide) that is translucent brown in transmitted light and comprises angular cells, and in having 5(-6)-septate ascospores that become pale brown, smooth to mostly verruculose. The peridium of *Miyoshiella* is wider (up to 25-40 µm wide), and formed of thick-walled, dark-brown angular cells with opaque walls, and has ascospores 3-septate, hyaline and smooth. I doubt that the generic classification of the anamorph of *C. ampulliformis*. The anamorph was assigned by Sivanesan & Chang (1997) to *Hemicorynespora* M.B. Ellis as the first species of the genus to have phragmosporous conidia. It may be better to restrict *Hemicorynespora* to the amero- or didymosporous species as described by Ellis (1972), Matsushima (1981) and Holubová-Jechová (1987). Sivanesan & Chang (1997) suggested the conidiogenesis to be tretic. The anamorph conforms well to the description of *Sporidesmium clarkii* P.M. Kirk (Kirk, 1982). The conidia of both *H. multiseptata* and *S.*

clarkii are similar in the 4-5-septate, obclavate, brown conidia with the apical cell paler, and lageniform proliferation of the conidiophore. Neither conidiogenesis nor conidium secession of *S. clarkii* was mentioned (Kirk, 1982). Conidia of *H. multiseptata* are of the same length but narrower than those of *S. clarkii*. Conidia of *S. clarkii* were seen germinated directly by scolecosporous conidia from short, ampuliform phialides. This character is unusual in *Sporidesmium* sensu lato. On the basis of perithecial and ascospore anatomy and the anamorph, *C. ampulliformis* should be excluded from the genus *Chaetosphaeria* and the Chaetosphaeriaceae. Its affinity lies probably among the genera of the Trichosphaeriaceae with *Endophragmiella* and *Sporidesmium* anamorphs, where it may represent a new taxon.

Umbrinosphaeria and *Miyoshiella* are widespread in the temperate zone of Asia, Europe, North America and New Zealand as their anamorphs, that are saprobes on woody substrata and occur more frequently than the teleomorphs. Teleomorphs are known from Central Europe, China, Japan and North America. Perithecia of *Umbrinosphaeria* and *Miyoshiella* are uncommon and easily overlooked. They are always scattered to gregarious among the conidiophores that form dark, remarkable black, effuse, hairy colonies on woody substrata, and makes its collection much easier.

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STUDIES IN CHAETOSPHAERIA SENSU LATO IV. CRASSOCHAETA GEN. NOV., A NEW LIGNICOLOUS GENUS OF THE TRICHOSPHAERIACEAE

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ABSTRACT

The new genus in the Trichosphaeriaceae *Crassochaeta* is introduced and two new combinations, *Crassochaeta nigrita* and *Crassochaeta fusispora*, are proposed. *Crassochaeta* is distinguished by the superficial, large, ovoidal to subglobose, setose perithecia; asci with a distinct refractive, J- apical annulus; persistent paraphyses and versicoloured, 3-septate ascospores. Ascospores of *Crassochaeta nigrita* germinate by producing phialides directly. Species of *Crassochaeta* are saprobes occurring on decaying wood in tropical and temperate regions. They are described and illustrated and their relationships with genera of the Chaetosphaeriaceae, Helminthosphaeriaceae and Trichosphaeriaceae are discussed. An index to the fungi treated in this series of publications, „Studies in *Chaetosphaeria* sensu lato I-IV.“ is provided. Keys to genera and families treated in this series are provided.

Key words. Ascomycotina, wood-inhabiting fungi, systematics, index, keys.

INTRODUCTION

Recently, during a revision of *Chaetosphaeria* Tul. & C. Tul. the type material of the peculiar fungi *Chaetosphaeria nigrita* (Berk. & Broome) Petch and *Chaetosphaerella fusispora* Sivan. were examined. *Chaetosphaerella fusispora* is known from several collections from Great Britain (Sivanesan, 1976). *Chaetosphaeria nigrita* was originally described from Ceylon as *Sphaeria nigrita* Berk. & Broome (Berkeley & Broome, 1873). It is apparently a pantropical species as additional collections have been found by Rick in southern Brazil and by Teng in tropical China (Tan-hsien province) as *Chaetosphaeria hainanensis* S. Teng.

Chaetosphaerella fusispora and *Chaetosphaeria nigrita* do not match the generic concept of *Chaetosphaeria* given by Tulasne & Tulasne (1863) because of the perithecia are larger (200-440 µm wide) and setose; the peridium is wide, leathery and comprises thick-walled angular cells; ascospores are 3-celled and versicoloured and no anamorph is known for

them. Species of *Chaetosphaeria* have smaller (100-250 μm wide) and glabrous perithecia; the peridium is thin, fragile and comprises thin-walled, opaque, brick-like cells; ascospores are 1-3-septate and hyaline and anamorphs are dematiaceous hyphomycetes with enteroblastic-phialidic conidiogenesis.

Chaetosphaeria nigrita and *Chaetosphaerella fusispora* share characters of perithecia, peridium, asci and ascospores that are unusual among the pyrenomycetous ascomycetes. These species are congeneric but cannot be accommodated in any known genus. The peridium anatomy, hamathecium and ascal anatomy suggest the family Trichosphaeriaceae G. Winter to be a home for them. Therefore, a new genus *Crassochaeta* is described with two species, *Crassochaeta fusispora* and *Crassochaeta nigrita*, for which new combinations are proposed. No anamorph was found to be associated with the perithecia of *Crassochaeta fusispora*. The identity of the anamorph of *Crassochaeta nigrita* is unknown. Conidia have been observed scattered among the hyphae of the subiculum or attached to the surface of the perithecia but could not be identified with any known hyphomycetous genera.

Chaetosphaeria helicteridis R. Rao, *Chaetosphaeria elegans* Rick, *Chaetosphaeria longipila* Peck and *Chaetosphaeria ornata* Harkn. are considered also and their relationships with *Crassochaeta* and other genera are discussed.

MATERIALS AND METHODS

For materials and methods refer to the first part of this series of publications (Réblová, 1999a).

TAXONOMIC PART

Crassochaeta Réblová, gen. nov.

Perithecia superficialia, ovata, papillata, dense setosa, setis crasse tunicatis, hyphis subiculi sparsis vel hyphis subiculi crasse tunicatis simpliciter furcatis vel multiramosis insidentia; parietibus bistratos. Ostiolum periphysatum. Hamathecium cum paraphysibus persistentibus. Asci unitunicati, 8-spori, cylindraneo-clavati, non amyloidei, annulo apicali distincto, refractivo. Ascosporae fusiformes usque ellipsoideae, 3-septatae, versicolores, cellulis centralibus brunnescentibus, cellulis apicalibus permanentemente hyalinis.

Species typica. Crassochaeta nigrita (Berk. & Broome) Réblová.

Figs. 1-12. ***Crassochaeta nigrita***. - 1, 2. Mature, setose perithecia. - 3, 4. Old, nonsetose perithecia whose setae disappear with age. - 5. Seta of the subiculum. - 6, 7. Young part of mycelium of the subiculum. - 8-12. Setae of the subiculum. - Figs. 1-12: BF. - Figs. 1, 2, 6-7 from CUP-CH 661; 3-5 from PACA 12675; 8-12 from K 37405. - Scale bars: 1-4 = 250 μm ; 5, 9-11 = 50 μm ; 6, 7 = 10 μm ; 8 = 20 μm ; 12 = 100 μm .



Perithecia superficial, ovoidal to subglobose, papillate, setose, not collapsing or collapsing by lateral pinching when dry, subiculum sparse or lacking or perithecia clustered on a dense subiculum composed of the multi-branched setae.—Peridium leathery, consisting of two layers; the outer layer of angular, thick-walled cells, Munk pores present in the wall cells of *C. nigrita*.—Ostiolar canal periphysate.—Paraphyses cylindrical, septate, constricted at the septa, branching, persistent.—Asci unitunicate, 8-spored, apex with a distinct, J-, refractive apical annulus.—Ascospores fusiform to ellipsoidal, 3-septate, versicoloured, the two middle cells becoming dark brown, the two end cells remaining hyaline.

TYPE SPECIES. *Crassochaeta nigrita* (Berk. & Broome) Réblová.

ANAMORPH. Unknown.

SYSTEMATIC POSITION. Trichosphaeriaceae G. Winter, Trichosphaeriales M.E. Barr.

ACCEPTED TAXA. Two species are accepted.

ETYMOLOGY. „crasso“ is derived from the latin *crassus* = thick, refering to the thick-walled setae covering the perithecia, the similar setae also present in the subiculum; „chaeta“ is derived from the greek *chaeta* = bristle, long hair.

1. ***Crassochaeta nigrita*** (Berk. & Broome) Réblová, comb. nov.

Figs. 1-20.

= *Sphaeria nigrita* Berk. & Broome, J. Linn. Soc. Bot. 14: 125, 1873. - basionym.

= *Eriosphaeria nigrita* (Berk. & Broome) Sacc., Syll. Fung. 1: 599, 1882.

= *Chaetosphaeria nigrita* (Berk. & Broome) Petch, Ann. Roy. Bot. Gard., Peradeniya 6: 331, 1917.

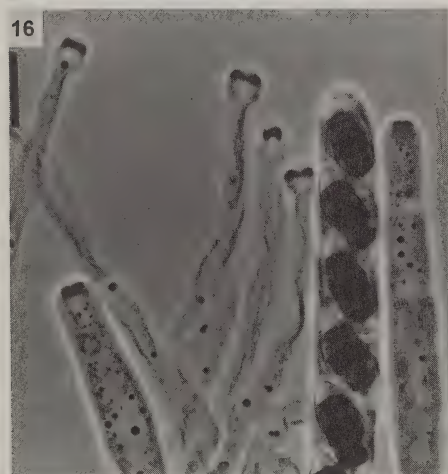
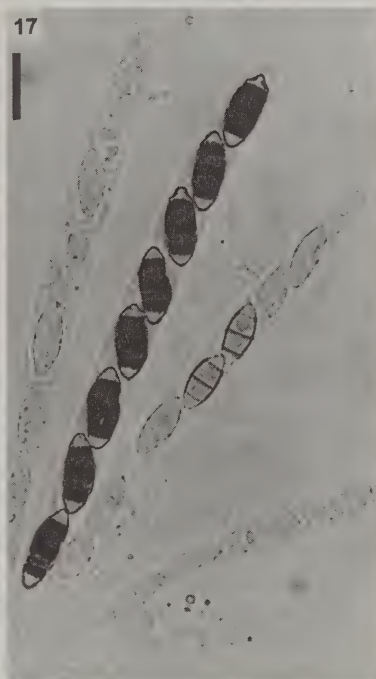
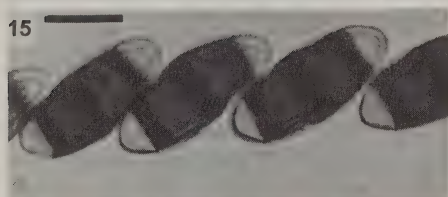
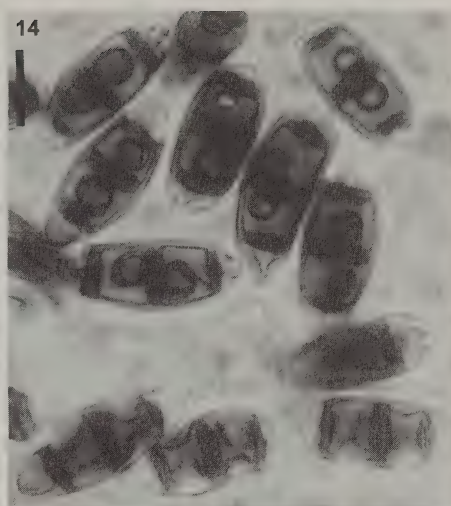
= *Chaetosphaeria hainanensis* S. Teng, Sinensia 6: 194, 1935.

ANAMORPH. Unknown, conidia look like *Arthrimum* Kunze: Fr.

Fig. 21.

Perithecia superficial, densely gregarious, conical to ovoidal with a narrow base, dark brown to black, glistening, slightly roughened, 460-760 µm high and 280-440 µm diam, setose, ostiolate, papillate; papilla conical, glabrous, 110-140 µm high and 130-170 µm diam. Perithecia crowded on a dense subiculum of dark brown, branched hyphae, 3-4 µm wide; some branches upright bearing dichotomously branched or three to multi-branched, septate setae, 20-80(-100) µm long (measured from the point of the branching) and 3-7 µm wide. The setae covering the ascوماتа are

Figs. 13-17. ***Crassochaeta nigrita***. - 13. Asci containing ascospores. - 14, 15. Ascospores. - 16. Upper parts of the mature ascus and empty asci. Note the conspicuous apical annulus. - 17. Ascus. - Figs. 13, 15, 17: BF; 14, 16: PC. - Figs. 13-15 from CUP-CH 661; 16, 17 from K 37405. - Scale bars: 13 = 100 µm; 14, 15 = 10 µm; 16, 17 = 20 µm.



nonseptate, predominantly unbranched or seldom dichotomously branched, 57-190 μm long, 5-7(-11) μm wide in the middle and 10-14(-20) μm wide at the bulbous base. Setae dark brown, opaque, rigid, tapering and strongly pointed at their apices, never conidiogenous.—Peridium leathery, 41-55 μm wide, consisting of two layers. Outer layer of angular cells, 4-7 μm in diam, provided with Munk pores in the wall, cells heavily pigmented on the surface of the peridium; inner layer of thin-walled, nonpigmented, compressed cells.—Ostiole canal periphysate.—Paraphyses persistent, cylindrical, slightly tapered towards the apex, hyaline, septate, 9-11 μm wide, septate at intervals of 11-26(-60) μm .—Asci unitunicate, 8-spored, (110-)120-145(-150) $\times$ (11-)12-15.5(-19) μm , rounded at the top, cylindrical, short stipitate, young asci staining deeply in Congo Red, apex with a distinct, J-, refractive apical annulus. The annulus easily seen especially in empty asci.—Ascospores ellipsoidal, (18.5-)21-26(-29) $\times$ (7-)8-9.5(-12) μm , 4-celled, not constricted at the septa, thickened at the septa with a darker band of colour in the ascospore wall, the two middle cells becoming brown and the two end cells remaining hyaline and ultimately collapsing and the ends then appearing truncate, with a large oil drop in each cell, obliquely 1-seriate in the ascus. Several mature ascospores observed to have germinated by directly producing short phialides; phialides 3-4 $\times$ 1-2 μm with collarette 0.5 μm wide.

ANAMORPH IN NATURE. In seven of the eight examined collections, including the type material of *Sphaeria nigrita*, single conidia were scattered among the hyphae of the subiculum or attached to the surface of the perithecia. Conidia ellipsoidal to lemon-shaped, dark brown to black, opaque, with a germ slit along nearly the whole spore length, 11-14(-16) $\times$ (4-)6-7 μm . Conidiogenous cells and conidiophores not observed.

MATERIAL EXAMINED. 1) Type material. CHINA. Hainan, Tan-hsien, on decayed wood, 5 Dec. 1934, S. Q. Deng 7256 (CUP-CH 661 - paratype of *Chaetosphaeria hainanensis*). - SRI LANKA. Hakgalla, on dead wood, Dec. 1867, Thwaites (K 37405 - holotype of *Sphaeria nigrita*).

2) Additional material. BRAZIL. São Leopoldo, on dead wood, 1935, J. Rick (PACA 12667, PACA 12675). - *ibid.*, 1929, Braun (PACA 12678). - San Salvador, 11 July 1944, J. Rick (PACA 22663). - *ibid.*, 8 Aug. 1943, J. Rick (PACA 20268). - *ibid.*, 27 Oct. 1943, J. Rick (PACA 20144). - Santa Maria, on decayed wood, 1936, J. Rick (PACA 12680).

DESCRIPTIONS AND ILLUSTRATIONS. Berkeley & Broome (1873: 125, Pl. 7, Fig. 40a-c), Petch (1917: 331), Teng (Sinensia, 6: 194, 1935) and Rick (Broteria, 5: 136, 1906).

HABITAT. Lignicolous saprobe on decaying woody material.

KNOWN DISTRIBUTION. The species has a widespread tropical distribution; it has been found in Asia (China, Sri Lanka) and South America (Brazil). Other reliable reports come from Central America (Costa Rica, Panama), where the fungus was collected recently (Sabine M. Huhndorf - personal communication).

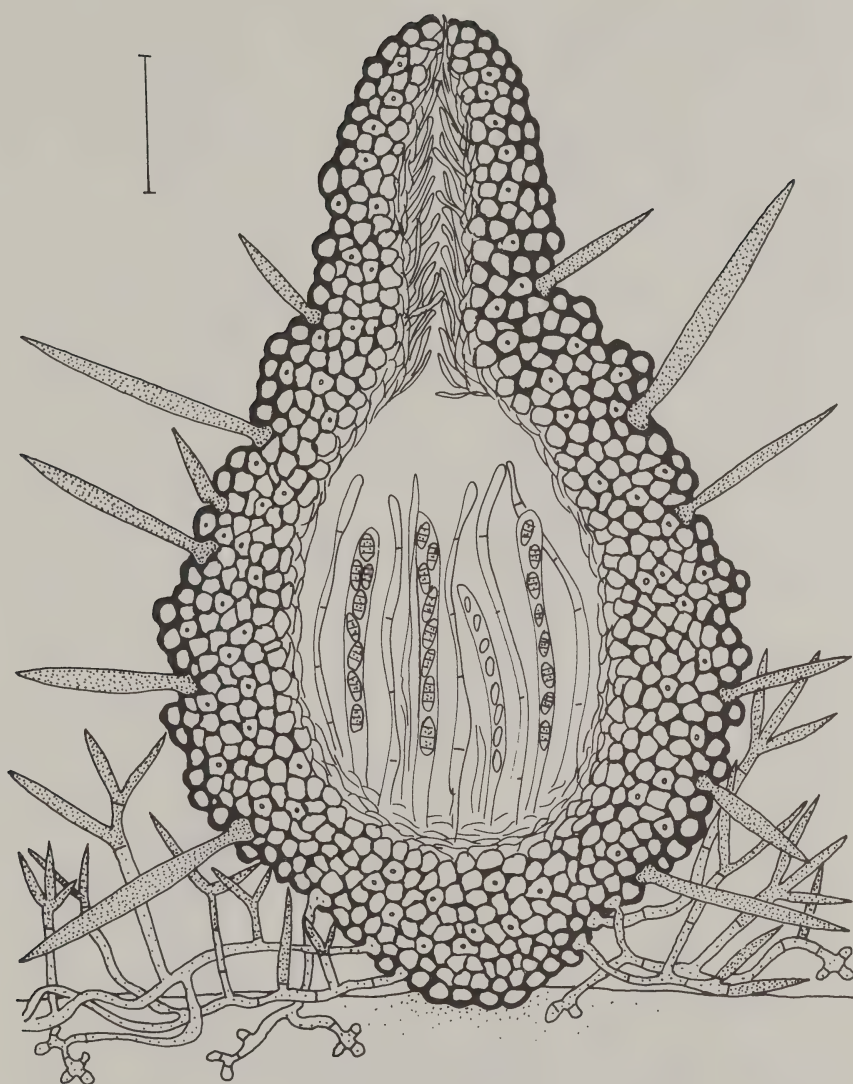


Fig. 18. *Crassochaeta nigrita*. - Median, longitudinal section of perithecium.
 - From K 37405. - Scale bars = 100 μ m.

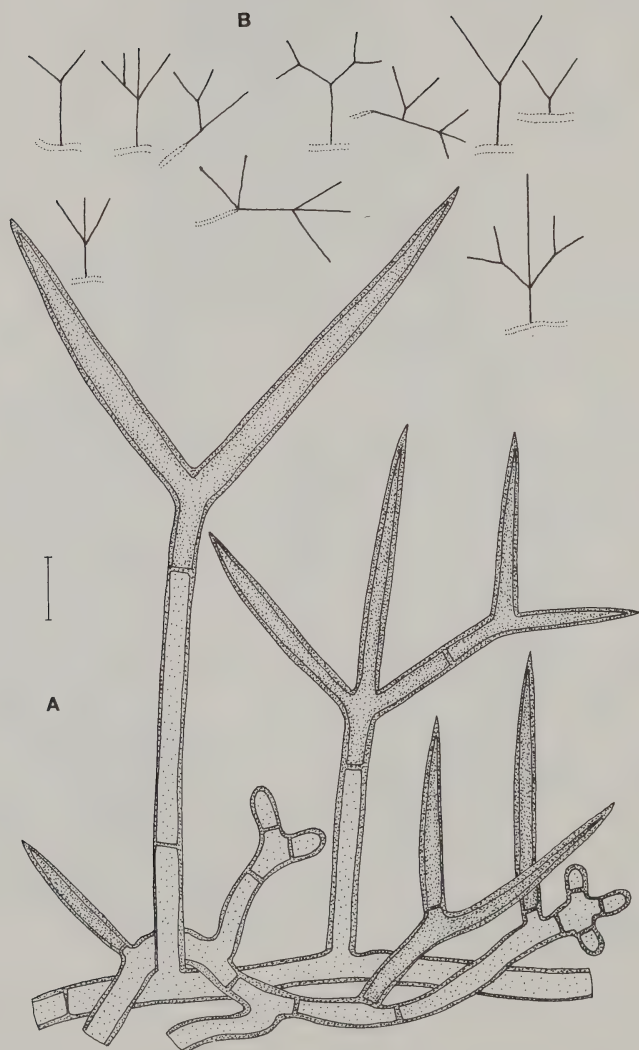


Fig. 19 A, B. *Crassochaeta nigrita*. - A. Setae and mycelium of the subiculum. - B. Habit sketch of different kinds of branching of multi-branched setae of the subiculum. - A, B from K 37405. - Scale bars: A = 10 μ m.

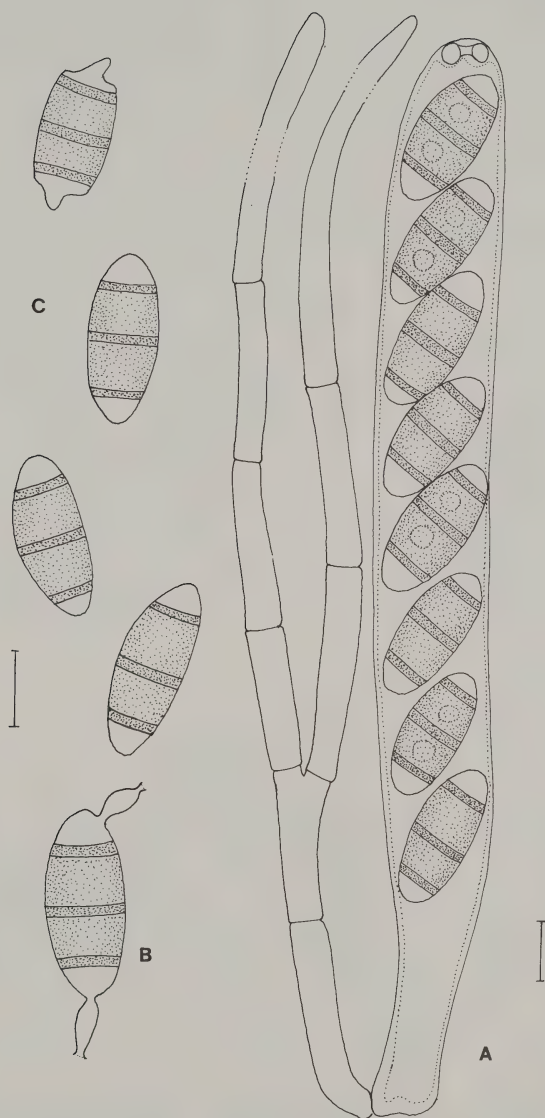


Fig. 20 A-D. *Crassochaeta nigrita*. - A. Ascus with ascospores and paraphyses. - B. Ascospore germinating by phialides. - C. Mature and collabent ascospores. - A-C from K 37405. - Scale bars: A-C = 10 μ m.

The ascospores germinate directly by phialides in two collections (K 37405 - holotype of *Sphaeria nigrita*; PACA 12678) but no conidia were present. I was not able to identify the conidia of the associated anamorph to any genus of dematiaceous hyphomycetes. The conidia somewhat resemble those of the hyphomycete genus *Arthrinium*, the anamorph of *Apiospora* Sacc. of the Apiosporaceae K.D. Hyde & al., in the shape, colour and presence of the germ slit.

Crassochaeta nigrita is distinct from *Crass. fusispora* by ovoidal perithecia seated in the dense, black, shining, multi-branched hyphae of the subiculum; opaque, dark, acute, spine-like setae and the ascospores that are typically thickened by a darker band at the septa.



Fig. 21. *Crassochaeta nigrita*. - Conidia observed attached to the setae and perithecia. - From K 37405. - Scale bars = 10 μ m.

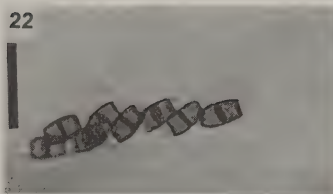
2. *Crassochaeta fusispora* (Sivan.) Réblová, comb. nov. Figs. 22-29.
 = *Chaetosphaerella fusispora* Sivan., Trans. Brit. Mycol. Soc. 67: 475, 1976. - basionym.

= *Chaetosphaeria fusispora* P. Larsen, Dansk. Bot. Arkiv 14: 7, 1952 (Illegitimate. Art. 53.1.) non *Chaetosphaeria fusispora* (Kawamura) Hino, Bull. Miyazaki Coll. Agr. For. 4: 191, 1932 nec *Chaetosphaeria fusispora* W. Gams & Hol.-Jech., Stud. Mycol. 13: 45, 1976.

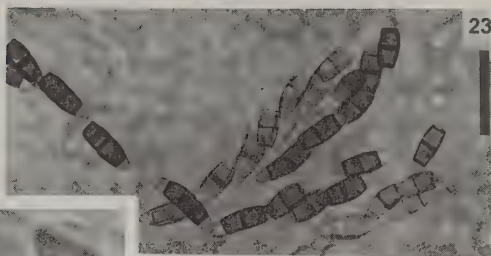
ANAMORPH. Unknown.

Figs. 22-27. *Crassochaeta fusispora*. - 22, 23. Asci containing ascospores. - 24, 25. Paraphyses. - 26. Longitudinal section of the upper part of perithecium. Note protruding cells on the surface. - 27. Longitudinal section of lateral perithecial wall in detail. - Figs. 22, 23, 26, 27: BF; 24, 25: PC. - Figs. 22-25 from IMI 179183; 26, 27 from IMI 192744. - Scale bars: 22-25, 27 = 20 μ m; 26 = 10 μ m.

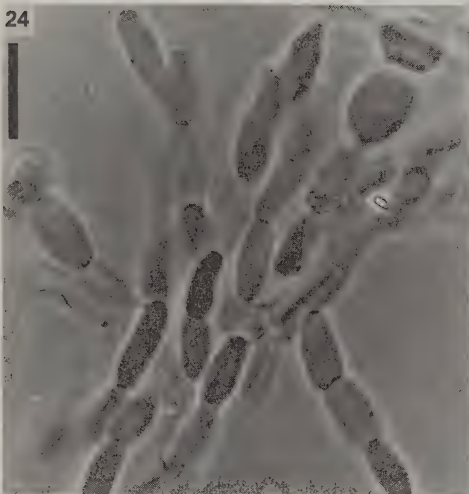
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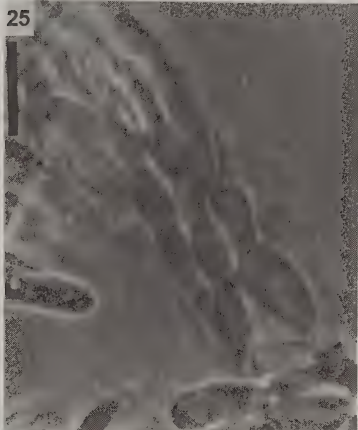
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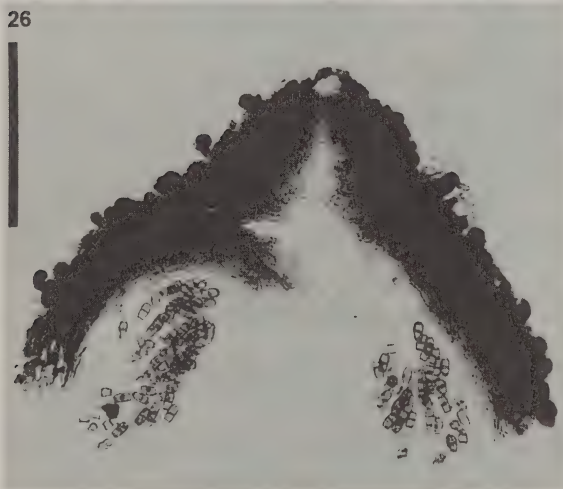
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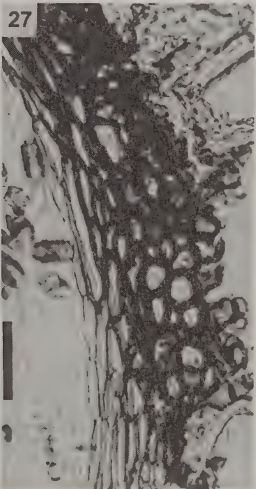
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26



27



Perithecia superficial, scattered or in small groups of 2-3, globose to subglobose, ostiolate, not collapsing, black, glistening, roughened, 200-350 μm high and 200-300 μm diam, setose, papillate.—Setae arising from the upper part of the perithecium, dark brown, septate, unbranched, stiff, erect, tapering, pointed to slightly obtuse, to 200 μm long, 4-6 μm wide in the middle and 10-11 μm wide at the base, never conidiogenous. Sparse hyphae growing from the base of the perithecia; hyphae pale brown, septate, branched, 14-15 μm wide.—Peridium leathery to brittle, in surface view *textura angularis*; lateral wall consisting of two layers. Outer layer 23-42 μm wide, cells angular, brown, thick-walled, on the exterior with dark brown, opaque and easily detached protruding cells; groups of those cells sometimes forming little pustules. Inner layer 2-3 μm wide, consisting of 2-3 layers of hyaline, elongated, compressed cells.—Ostiole canal periphysate.—Paraphyses persistent, apically free, abundant and extending beyond the asci, cylindrical, 8-10 μm wide, septate, branched, strongly constricted at the septa.—Asci unitunicate, 8-spored, (67-)73-91(-101) $\times$ (9.5-)10-11.5(-12) μm , stipe 27-30 μm long, arising in a broad hymenium, clavate, long stipitate, broadly rounded at the top, apex with a thin, J-, refractive apical annulus.—Ascospores fusiform, (13.5-)15.5-17.5 (-19.5) $\times$ (4.5-)5-6(-7) μm , 4-celled, slightly constricted at the septa, at the septa not thickened, the two middle cells becoming brown, the two terminal cells remaining hyaline, 2-seriate in the ascus.

MATERIAL EXAMINED. 1) Type material. GREAT BRITAIN. Wales, Denbighshire, Loggerheads, on branch of *Acer pseudoplatanus*, 20 Sept. 1973, R. J. Bevan (IMI 179183 - neotype of *Chaetosphaerella fusispora*, designated here).

2) Additional material. GREAT BRITAIN. Wales, Denbighshire, Loggerheads, on branch of *Acer pseudoplatanus*, 20 Sept. 1973, R. J. Bevan (IMI 192664). - Cambridgeshire, Anglesey Abbey, on branch of *Acer pseudoplatanus*, 8 Sept. 1974, R. J. Bevan (IMI 192744).

DESCRIPTIONS AND ILLUSTRATIONS. Larsen (1952: 7, Fig. 1), Sivanesan (1976: 475, Fig. 4).

HABITAT. Saprobe on decayed wood and bark.

KNOWN HOST. *Acer pseudoplatanus*.

KNOWN DISTRIBUTION. Europe, known only from Great Britain.

When Larsen (1952) described *Chaetosphaeria fusispora* P. Larsen he made a later homonym of *Chaetosphaeria fusispora* (Kawamura) Hino. Sivanesan (1976) created a new name for it, *Chaetosphaerella fusispora* Sivan., which he based on the illegitimate basionym *Chaetosphaeria fusispora* P. Larsen. The type material of *Chaetosphaeria fusispora* collected by Larsen (Larsen, 1952) is lost. Sivanesan redescribed *Chaetosphaerella fusispora* from collections made by R. J. Bevan in Great Britain but did not designate a neotype. Therefore, the neotype is chosen here from the collections examined by Sivanesan (1976).

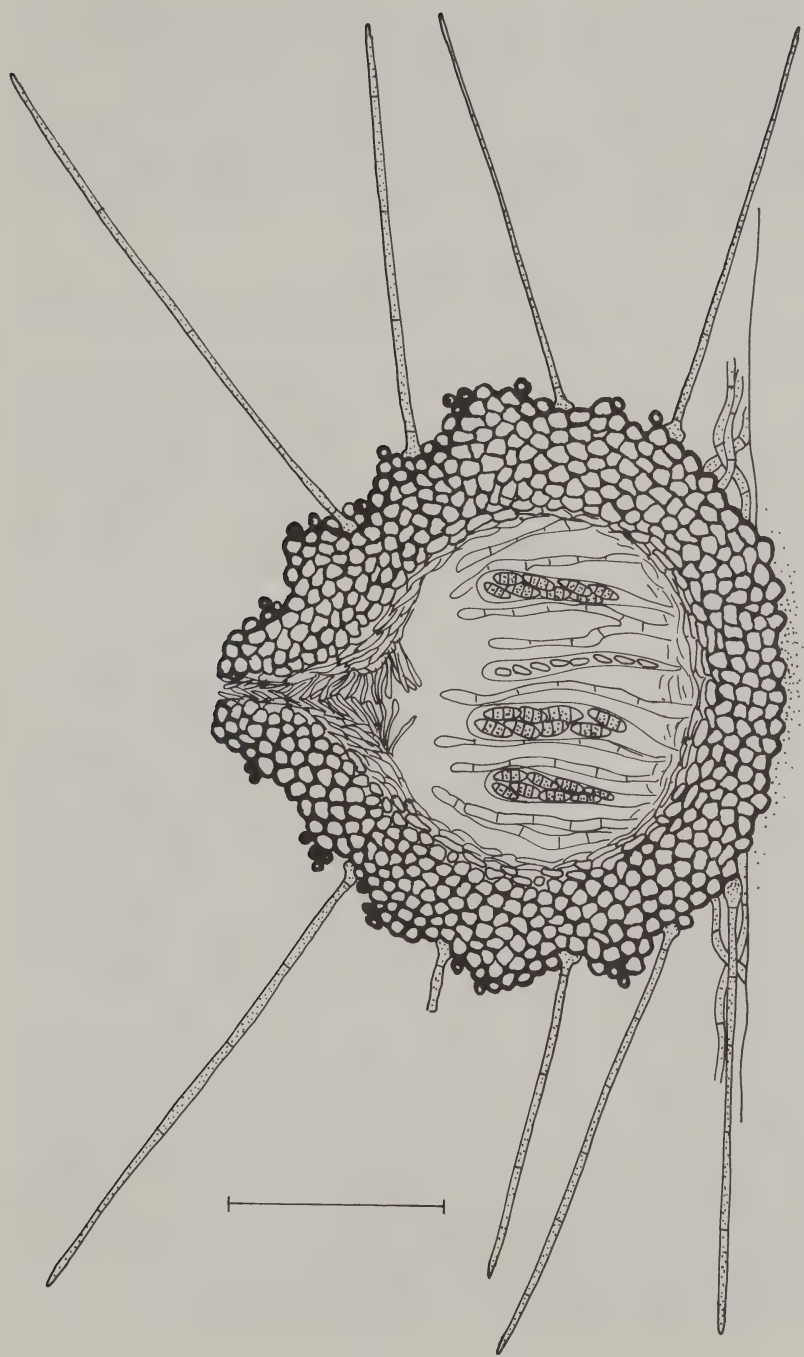


Fig. 28. *Crassocharaeta fusicpora*. - Median, longitudinal section of perithecium. - From IMI 179183. - Scale bar = 100 μ m.

Although the fungus is so far known only from Great Britain and Denmark, it is probably widespread in the temperate zone. It is inconspicuous, and thus easily overlooked. Sivanesan (1976) unsuccessfully tried to grow this fungus in culture and the anamorph is still unknown.

Crassochaeta fusispora differs from *Crass. nigrita* in having globose to subglobose perithecia covered by longer and narrower, septate setae; lacking of dense, setose subiculum, and by the clavate asci and ascospores that are not thickened at the septa.

DISCUSSION

Crassochaeta is easily recognized in the Trichosphaeriaceae owing to the combination of characters of the perithecium, peridium, hamathecium, asci and ascospores.

Crassochaeta should be compared with *Ascocodinaea* Samuels & al. of the Chaetosphaeriaceae Réblovár & al. and *Chaetosphaerella* E. Müll. & C. Booth and *Tengiomyces* Réblová of the Helminthosphaeriaceae Samuels & al. Among those genera, the two latter possess setae similar to those described for *Crassochaeta nigrita* but the perithecia of *Chaetosphaerella* are obpyriform, stalked, glabrous, tuberculate, and provided with setae only at the base. *Chaetosphaerella* is also distinct from *Crassochaeta* in the ascus, hamathecium and ascospore anatomy; asci of *Chaetosphaerella* contain a thin, rather indistinct apical annulus, paraphyses are broadly cellular, present only in young stages of the perithecium development and deliquesce early. Ascospores are oblong and have never been observed to germinate by phialides. The synanamorphs of *Chaetosphaerella* belong to the hyphomycete genera *Oedemium* Link and *Veramycina* Subram. *Tengiomyces* has globose, setose, nonpapillate perithecia seated in a sparse, pale brown, velvety subiculum; asci are thick-walled at the top and have an indistinct, J- apical annulus; paraphyses are early deliquescent. The associated anamorph of *Tengiomyces* is presumed to belong to the hyphomycete genus *Spadicoides* S. Hughes (Réblová, 1999a), and it is morphologically distinct from that found associated with the ascomata of *Crassochaeta nigrita*. *Crassochaeta* differs from *Ascocodinaea* in much larger, ovoidal to subglobose perithecia that may be crowded on a multi-branched, setose subiculum in *Crass. nigrita*, or the subiculum is sparse or even lacking in *Crass. fusispora*; the peridium in *Crassochaeta* is wide and comprises thick-walled, brown, angular cells; the apical annulus is large and refractive; the distinct anamorph that is regularly associated with perithecia of *Crass. nigrita*, in morphology distinct from *Dictyochoeta* anamorph of *Ascocodinaea* species. *Ascocodinaea* has smaller, setose, globose to conical perithecia seated in a sparse pale subiculum; the peridium is thin, translucent brown in transmitted light and comprises thin-walled, brick-like cells; asci have a thin apical annulus; ascospore septa are not thickened and the anamorph is *Dictyochoeta* Speg. (as *Codinaea*, Samuels & al., 1997) with enteroblastic-phialidic conidiogenesis.



Fig. 29A, B. *Crassochaeta fusispora*. - A. Asci, paraphyses and ascospores. - B. Ascospores. - A, B from IMI 179183. - Scale bars: A, B = 10 μ m.

Doubtful species

Chaetosphaeria elegans Rick, Broteria 5: 137, 1906.

TYPE. BRAZIL. Rio Grande do Sul, on decaying wood, J. Rick.

The type and any other authentic material is apparently lost. The main characteristics of the fungus were given by Rick as follows: ascomata gregarious, black, setose, collapsing, subglobose, 750 μm in diam, sitting in a subiculum consisting of multi-branched setae distinct from those covering the ascomata; asci 100 $\times$ 10 μm , thickened at the apex, short stipitate; paraphyses present; ascospores cylindrical, 10-14 $\times$ 5-6 μm , 3-septate, versicoloured, the middle cells becoming brown and the end cells remaining hyaline.

Based on its description, *Chaetosphaeria elegans* fits well into the generic concept of *Crassochaeta*, which is given in the present paper. *Chaetosphaeria elegans* and *Crassochaeta nigrita* seem to be congeneric and, if transferred to *Crassochaeta*, *Chaetosphaeria elegans* would be clearly distinguishable from *Crassochaeta nigrita* by the size of the asci and ascospores at the species level. However, I prefer not to include *C. elegans* in *Crassochaeta*, despite of a number of apparent similarities with other species in the genus, until it is recollected and examined again.

Chaetosphaeria helicteridis R. Rao, Sydowia 24: 323, 1971.

TYPE. INDIA. on dead and dry stems of *Helicteres isora*, Aug. 1968, Ramchandra Rao (M.S. 107).

The type specimen, requested from the herbarium MSG College, Maharashtra, India, was not available. The following description is taken from Rao (1971): ascomata globose with minute papilla, sitting in a black hyphal tomentum; hairs 150-300 $\times$ 5-6 μm , pointed or slightly rounded at the top, covering the lower part of the ascomata. Asci 8-spored, 80-120 $\times$ 15-20 μm , bitunicate and figured with thickened ascal apex and 3-celled, versicoloured, oblique 1-seriately placed ascospores 15-25 $\times$ 6-9 μm . The presence or absence of paraphyses was not mentioned.

Judging from the protologue, the size of the ascospores of *Chaetosphaeria helicteridis* and *Crassochaeta nigrita* overlap significantly, the length of their asci is also similar. Both species differ in the width of the asci and also in morphology of the ascomata and setae. *Chaetosphaeria helicteridis* could be a member of the Trichosphaeriaceae, but its relationships with other taxa and the position in that family remain questionable. The present author hesitates to make any deeper conclusions and formal changes without having seen the type material.

Chaetosphaeria ornata Harkn., Bull. Calif. Acad. Sci. 1: 45, 1884.

TYPE. U.S.A. California, cemetery, on bark and wood of *Eucalyptus globulus*, Aug. 1881, Harkness, Harkness's Collection of Fungi, No. 2845 (BPI 622123!).

The species was described by Harkness (1884) as follows: „perithecia superficial, orbicular, black, not rugulose, 360 μm wide, setae hyphoid, 500 μm or more in length, not acuminate, occasionally septate; asci 8-spored, mucoid, clavate, with a long pedicel filled with oil globules or granules, 100 $\times$ 8-10 μm ; paraphyses hardly visible; sporidia fusiform, 3-septate, the middle cells olive-brown, the ultimate cells hyaline, 16 $\times$ 6 μm “.

The type specimen (BPI) did not contain any perithecia. Because original material of *C. ornata* was depauperate, the identity of this species is unknown. Judging from the protologue, the fungus resembles *Crassochaeta fusispora*.

Chaetosphaeria longipila Peck, New York State Mus. Rep. 42: 131, 1889.

= *Litschaueria longipila* (Peck) M.E. Barr, Bull. New York State Mus. 459: 28, 1986.

TYPE. U.S.A. New York, Flatbush, Long Island, Kings Co., on old barrel bottom in a cellar, March 1888, J. L. Zabriskie 73 (NY 508!).

Ascomata superficial, solitary or in small groups, ovoidal to subglobose, base slightly immersed, papillate, roughened, covered by long, subhyaline to yellowish, nonseptate appendages; appendages rounded at the apex and provided with short denticles on the surface. Ascomatal wall 33-44 μm wide, consisting of thick-walled, melanized cells, *textura angularis*. Hamathecium of numerous, hyaline, branching, anastomosing paraphysoides, 1-1.5 μm wide. Asci bitunicate, 8-spored, 54-71 $\times$ 13-15 μm , distinctly thickened at the top, apex J-, lacking any visible discharge apparatus. Ascospores fusiform, 12-17 $\times$ 6-7 μm , biseriate with overlapping ends; when young 2-celled and subhyaline with a dark median septum, later two additional septa forming, the median septum becoming darker and thicker, the middle two cells becoming brown and the end cells remaining hyaline; wall longitudinally striate.

The bitunicate asci indicate that the fungus is a loculoascomycete. Barr & al. (1986) reviewed the type material of *Chaetosphaeria longipila* but did not describe the appearance of the asci and ascal apex. The asci were only illustrated and the drawing does not show any visible discharge mechanism at the ascal apex.

Index of Fungi treated in the series „Studies in *Chaetosphaeria* sensu lato I-IV“

Following a list of fungi treated in this series „Studies in *Chaetosphaeria* sensu lato I-IV.“ The fungi included in this series all have 3-7-septate versicoloured ascospores or 3-septate hyaline ascospores. These fungi, currently placed in *Chaetosphaerella*, *Chaetosphaeria* or *Lasiosphaeria* are reclassified and transferred to other seven genera, including *Chaetosphaerella*. An additional five species of *Chaetosphaeria* that have 7-septate, versicoloured ascospores and have previously been placed in

Melanochaeta E. Müll., Harr & Sulmont (Müller & al., 1968; Réblová, 1997), are also listed.

Unless otherwise indicated, the numbers I-IV refer to the individual parts of this series, where the species cited are described.

- I Studies in *Chaetosphaeria* sensu lato I. The genera *Chaetosphaerella* and *Tengiomyces* gen. nov. of the Helminthosphaeriaceae. (Réblová, 1999a)
- II Studies in *Chaetosphaeria* sensu lato II. *Coniobrevicolla* gen. & sp. nov. (Réblová, 1999b)
- III Studies in *Chaetosphaeria* sensu lato III. *Umbrinosphaeria* gen. nov. and *Miyoshiella* with *Sporidesmium* anamorphs. (Réblová, 1999c)
- IV Studies in *Chaetosphaeria* sensu lato IV. *Crassochaeta* gen. nov., the new lignicolous genus of the Trichosphaeriaceae. (Réblová, 1999d)

africana, *Chaetosphaeria* Saccas, Bull. Inst. Franç. Café & Cacao 16: 69, 1981. (Not validly published. Art. 37.)

Melanochaeta hemipsila (Berk. & Broome) E. Müll., Harr & Sulmont (Réblová, 1997).

bihyalina, *Sphaeria* Berk. & Broome, J. Linn. Soc. Bot., 14: 124, 1873.

Chaetosphaeria bihyalina (Berk. & Broome) Sacc., Syll. Fung. 2: 93, 1883.

Chaetosphaerella fusca (Fuckel) E. Müll. & C. Booth. I.

caelestinoides, *Chaetosphaeria* S. Teng, Sinensia 7: 502, 1936.

Umbrinosphaeria caesariata (Clinton & Peck) Réblová. III.

caesariata, *Sphaeria* Clinton & Peck, Ann. Rep. New York State Mus. Nat. Hist. 29: 60, 1875 (1878).

Lasiosphaeria caesariata (Clinton & Peck) Sacc., Syll. Fung. 2: 192, 1883.

Phaeotrichosphaeria caesariata (Clinton & Peck) M.E. Barr, Bull. New York State Mus. 459: 12, 1986.

Umbrinosphaeria caesariata (Clinton & Peck) Réblová. III.

caespitosa, *Chaetosphaeria* Höhnelt in Weese, Mitteil. Bot. Inst. Techn. Hochschule Wien 6: 97, 1929.

Umbrinosphaeria caesariata (Clinton & Peck) Réblová. III.

coelestina, *Chaetosphaeria* Höhnelt, Sitzb. K. Akad. Wiss. Wien, Math.-Natur. Kl. 118: 324, 1909.

Melanochaeta hemipsila (Berk. & Broome) E. Müll., Harr & Sulmont (Müller & al., 1968; Réblová, 1997).

coffaeae, *Chaetosphaeria* Saccas, Bull. Inst. Franç. Café & Cacao 16: 73, 1981. (Not validly published. Art. 37.)

Melanochaeta hemipsila (Berk. & Broome) E. Müll., Harr & Sulmont (Müller & al., 1968; Réblová, 1997).

elegans, *Chaetosphaeria* Rick, Broteria 5: 137, 1906. IV.

The species is related to *Crassochaeta nigrita*. The type and any other authentic material is apparently lost.

- fusca*, *Chaetosphaeria* Fuckel, Jahrb. Nassau. Ver. Naturk. 23-24: 166, 1870.
Thaxteria fusca (Fuckel) C. Booth, Naturalist 1958: 90, 1958.
Chaetosphaerella fusca (Fuckel) E. Müll. & C. Booth. I.
- fusispora*, *Chaetosphaerella* Sivan., Trans. Brit. Mycol. Soc. 67: 475, 1976.
Chaetosphaeria fusispora P. Larsen, Dansk. Bot. Ark. 14(7): 7, 1952 (Illegitimate. Art. 53.1.), non *Chaetosphaeria fusispora* (Kawamura) Hino, Bull. Miyazaki Coll. Agr. For. 4: 191, 1932 nec *Chaetosphaeria fusispora* W. Gams & Hol.-Jech., Stud. Mycol. 13: 45, 1976.
Crassochaeta fusispora (Sivan.) Réblová. IV.
- fusispora*, *Miyoshiella*** Kawamura, Jap. J. Bot. 4: 296, 1929. III.
Miyoshia fusispora Kawamura, J. Coll. Sci. Imp. Univ. Tokyo 23: 6, 1907. (Illegitimate. Art. 53.1.)
Chaetosphaeria fusispora (Kawamura) Hino, Bull. Miyazaki Coll. Agr. For. 4: 191, 1932, non *Chaetosphaeria fusispora* P. Larsen, Dansk. Bot. Ark. 14: 7, 1952, nec *Chaetosphaeria fusispora* W. Gams & Hol.-Jech., Stud. Mycol. 13: 45, 1976.
- hainanensis*, *Chaetosphaeria* S. Teng, Sinenesia 6: 194, 1935.
Crassochaeta nigrita (Berk. & Broome) Réblová. IV.
- helicteridis*, *Chaetosphaeria* R. Rao, Sydowia 24: 323, 1971. IV.
 The type specimen was not available. The species is apparently a member of the Trichosphaeriaceae.
- hemipsila*, *Sphaeria* Berk. & Broome, J. Linn. Soc., Bot., 14: 126, 1873.
Lasiosphaeria hemipsila (Berk. & Broome) Sacc., Syll. Fung. 2: 198, 1883.
Chaetosphaeria hemipsila (Berk. & Broome) Petch, Ann. Roy. Bot. Gard., Peradeniya, 6: 336, 1917.
Melanochaeta hemipsila (Berk. & Broome) E. Müll., Harr & Sulmont (Müller & al., 1968).
- incrustans*, *Chaetosphaeria* Rick, Broteria 3: 289, 1904.
Chaetosphaerella fusca (Fuckel) E. Müll. & C. Booth. I.
- indica*, *Chaetosphaerella* Varghese & V.G. Rao, Biovigyanam 5: 2, 1979.
Tengiomyces indicus (Varghese & V.G. Rao) Réblová. I.
- innumera*, *Chaetosphaeria* Berk. & Broome ex Tul. & C. Tul. sensu S. Teng, Sinensia 4: 364, 1934, non *Chaetosphaeria innumera* Berk. & Broome ex Tul. & C. Tul., Sel. Fung. Carp. 2: 252, 1863.
Tengiomyces indicus (Varghese & V.G. Rao) Réblová. I.
- iquitosensis*, *Chaetosphaeria* (P. Henn.) Theiss., in Herb. (Not published.)
Meliola iquitosensis P. Henn., Hedwigia 43: 361, 1904.
Meliolinopsis iquitosensis (P. Henn.) Beeli, Bull. Jard. Bot. Bruxelles 7: 119, 1920.
Meliolina iquitosensis (P. Henn.) Stev., Ann. Mycol. 25: 419, 1927.
Irenina iquitosensis (P. Henn.) Hansf., Proc. Linn. Soc. London 157: 169, 1946.

Asteridiella iquitosensis (P. Henn.) Hansf., Sydowia 10: 48, 1957. I.

Synonymy according to Hansford (1961).

larsenii*, *Coniobrevicolla Réblová. II.

larvata*, *Miyoshiella Réblová. III.

longipila*, *Chaetosphaeria Peck, New York State Mus. Rep. 42: 131, 1889. IV.

Litschaueria longipila (Peck) M.E. Barr, Bull. New York St. Mus. 459: 28, 1986.

The bitunicate asci indicate that it is a loculoascomycete.

multiseptata*, *Chaetosphaeria Wehmeyer, Canad. J. Res., Sect. C, 20: 576, 1942.

Umbrinosphaeria caesariata (Clinton & Peck) Réblová. III.

nigrita*, *Sphaeria Berk. & Broome, J. Linn. Soc., Bot. 14: 125, 1873.

Eriosphaeria nigrita (Berk. & Broome) Sacc., Syll. Fung. 1: 599, 1882.

Chaetosphaeria nigrita (Berk. & Broome) Petch, Ann. Roy. Bot. Gard., Peradeniya 6: 331, 1917.

Crassochaeta nigrita (Berk. & Broome) Réblová. IV.

ornata*, *Chaetosphaeria Harkn., Bull. Calif. Acad. Sci. 1: 45, 1884. IV.

According to the protologue this species is related to *Crassochaeta fusispora* Réblová. The type material was depauperate.

pezizaeformis*, *Chaetosphaeria Schulzer, Hedwigia 23: 78, 1884.

Umbrinosphaeria caesariata (Clinton & Peck) Réblová. III.

phaeostroma*, *Sphaeria Durieu & Mont., Flore d'Algérie p. 491, 1846.

Chaetosphaeria phaeostroma (Durieu & Mont.) Fuckel, Jahrb. Nassau. Ver. Naturk. 23-24: 166, 1870.

Thaxteria phaeostroma (Durieu & Mont.) C. Booth, Naturalist 1958: 88, 1958.

Chaetosphaerella phaeostroma (Durieu & Mont.) E. Müll. & C. Booth. I.

phaeostromoides*, *Sphaeria Peck, New York State Mus. Rep. 28: 77, 1876.

Chaetosphaeria phaeostromoides (Peck) Sacc., Syll. Fung. 2: 93, 1883.

Chaetosphaeria phaeostroma (Durieu & Mont.) Fuckel var. *phaeostromoides* (Peck) Ellis & Everh., North Amer. Pyrenomyc., p. 160, 1892.

Chaetosphaerella fusca (Fuckel) E. Müll. & C. Booth. I.

rehmiana*, *Lasiosphaeria P. Henn., Verh. Bot. Ver. Prov. Brandbg. 40: 155, 1898.

Chaetosphaeria rehmiana (P. Henn.) Kirschst., Krypt. Fl. Mark. Brandenb. 7: 236, 1911.

Melanochaeta hemipsila (Berk. & Broome) E. Müll., Harr & Sulmont (Réblová, 1997).

subcaespitosa*, *Chaetosphaeria P. Larsen, Dansk Bot. Arkiv 14: 8, 1952. II.

It is related to *Coniobrevicolla* Réblová. The type specimen could not be located.

triseptata, *Lasiosphaeria* Shoemaker & White, Sydowia 38: 282, 1985.

Miyoshiella triseptata (Shoemaker & White) Réblová. III.

tristis, *Chaetosphaeria* (Tode: Fr.) Schröter sensu Schröter, Die Pilze Schlesiens 3: 308, 1908, non *Sphaeria tristis* Tode: Fr., Syst. Mycol. 2: 444, 1823.

Chaetosphaerella phaeostroma (Durieu & Mont.) Fuckel. I.

Keys to families that are discussed

Key to genera of the Trichosphaericaeae

1. Perithecia glabrous 2
1. Perithecia setose 4
 2. Ascospores hyaline 3
 2. Ascospores versicoloured; anamorph unknown *Coniobrevicolla*
3. Ascospores fusiform, transversely 3-septate; *Sporidesmium* anamorph *Miyoshiella*
3. Ascospores obovoidal, becoming muriform; *Phaeoisaria* anamorph *Rhamphoria*
 4. Ascospores versicoloured 5
 4. Ascospores hyaline to subhyaline 6
5. Ascospores elongate fusiform; setae with subhyaline amorphous globule at the top; *Sporidesmium* anamorph *Umbrinosphaeria*
5. Ascospores ellipsoidal; setae dark, acute; anamorph unknown *Crassochaeta*
 6. Ascospores elongate fusiform, 3-septate, arranged in a fascicle in the ascus; anamorph unknown *Acanthostigma*
 6. Ascospores ellipsoidal to allantoid 7
7. Ascospores 1-celled 8
7. Ascospores more than 1-celled 9
 8. Ascospores ellipsoidal, uniseriate in the ascus; apical annulus J-; perithecia papillate; setae erect, scattered over the perithecia; anamorph unknown *Trichosphaeria*
 8. Ascospores ellipsoidal to allantoid; uni- to biseriate in the ascus; apical annulus J- or J+; perithecia nonpapillate; setae straight to flexuous, radiate as rope-like structures from the flat apex; *Ceratosporium* and *Selenosporella* synanamorphs *Iodosphaeria*
9. Perithecia campanulate, setose, nonpapillate; ascospores 2-celled, ellipsoidal with narrow ends; anamorph unknown *Setocampanula*
9. Perithecia globose to subglobose 10
 10. Ascospores 2-celled, uniseriate in the ascus; perithecia papillate; setae short; anamorph unknown *Eriosphaeria*

10. Ascospores 1-2(-3)-celled, uni- to biseriate in the ascus; perithecia nonpapillate; setae long, straight or flexuous; *Endophragmiella* anamorph *Phaeotrichosphaeria*

Key to genera of the Helminthosphaeriaceae

1. Perithecia obpyriform, with sterile base, provided by setae only at the base; ascospores oblong, versicoloured; *Oedemium* and *Veramycina* synanamorphs *Chaetosphaerella*
1. Perithecia globose to subglobose, setose, nonpapillate; ascospores ellipsoidal 2
2. Ascospores 1(-2-3)-septate, greyish-brown, with a single germ pore at each end; *Diplococcium* anamorph *Helminthosphaeria*
2. Ascospores 3-septate, versicoloured, nonporate; *Spadicoides* anamorph *Tengiomyces*

Key to genera of the Chaetosphaeriaceae see Réblová & al. (1999).

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MACROFUNGUS FLORA OF THE LAGOON OF VENICE AND ADJACENT AREAS (ITALY). NON-GILLED BASIDIOMYCETES. II. CORTICIOID FUNGI

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ABSTRACT: 95 species of *corticoid fungi* distributed into 46 genera for a total of 1314 findings are reported from the Lagoon of Venice and adjacent areas. Rare or more interesting species and deviating specimens are described and/or commentated and illustrated.

In a previous paper (Losi, 1997) I reported 17 species of *tomentelloid fungi* and I outlined the essential characteristics of the area concerned, giving an idea of the arbori-vegetation of the sandy litorals and of the immediate lagoon hinterland. The most representative trees of the islands which were possible to visit are *Robinia pseudoacacia* L., *Sambucus nigra* L. and *Tamarix gallica* L.. The islands of Carbonera and S. Giacomo in Palude have respectively many *Prunus avium* L. and *Ailanthus altissima* (Mill.) Swingle too. The islands which are, or have been strongly anthropogenic, are Venice, S. Lazzaro, S. Clemente, Sacca Sessola and S. Francesco del Deserto where there is also a certain variety of ornamental trees. The number of findings is given in brackets after the location distribution reference. The specimens are deposited in the author's private herbarium and in MCVE. The limits of the group *corticoid fungi* as in Jülich & Stalpers (1980) excluding *Heterobasidiomycetes* and the items detailed in my first paper. The nomenclature follows that of E. Parmasto (1997).

List of the localities the position of which can be found on the map. (Fig. 1).

- | | |
|--------------------------------------|--------------------------------------|
| 01 Asseggiano Wood | 08 Caroman Wood |
| 02 Carpenedo Wood | 09 Alberoni Wood |
| 03 Ca'Noghera Wood | 10 S. Nicolò Wood |
| 04 Mestre (public parks and gardens) | 11 Ca'Savio Wood. |
| 05 Valle Averte a wetland | 12 Venice (public parks and gardens) |
| 06 Reclaimed land Cassa colmata B | 13 Carbonera Island |
| 07 Certosa Island. | 14 Madonna del Monte Island |

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15 S. Giacomo in Palude Island.

16 Lazzaretto Nuovo Island.

17 S. Francesco del Deserto Island

18 S. Cristina Island

19 Ossario di S. Ariano Island

20 ex Salina Island

21 Caposile

22 Reclaimed land Cassa colmata A.

23 S. Giorgio in Alga Island

24 S. Clemente Island

25 Sacca Sessola Island

26 S. Angelo della Polvere Island.

27 ex Poveglia Island

28 Campana Island

29 S. Lazzaro Island

30 Lazzaretto Vecchio Island

31 Lido (public parks and gardens)



Fig. 1. Map of the localities.

Amphinema byssoides (Pers.) J. Erikss. (1958)

Colour of the hymenophore pure white to yellowish or pale yellowish ochre. Hyphoid cystidia slightly attenuate towards the apex, sometimes cylindrical or subcapitate. Basidiospores ellipsoid to cylindrical-ellipsoid, more rarely

broadly ellipsoid, ovoid or as in *A. arachispora* Burds. & Nakasone, 3.4-5 x 2.4-3.4 μm .

HABITAT: mostly on *Pinus* spp. and *Alnus glutinosa* but also collected on *Populus tremula*, *P. nigra*, *Robinia pseudoacacia* and *Salix* sp..

DISTRIBUTION: 8 (8), 9 (4), 11 (16).

Asterostroma cervicolor (Berk. & M.A. Curtis) Massee (1889). Fig. 2

Hymenial surface smooth, creamish to pale ochre with orange tinges; margin whitish arachnoid to byssoid or fibrillose. Basidiospores globose to subglobose, 5.6-6.8 (-8) μm in diam. excluding the warts which are up to 2 μm long (on the average 1.2-1.6 μm). For basidiospores characteristics of the specimen in question and the relationship with *A. medium* Bres., *A. ochroleucum* Bres. and *A. gaillardii* Pat. see Hallenberg (1985), Boidin et al. (1997) and Telleria et al. (1997).

HABITAT: on *Populus tremula*. DISTRIBUTION: 9 (1).

Athelia decipiens (Höhn. & Litsch.) J. Erikss. (1958).

HABITAT: on decayed cone of *Pinus pinea*. DISTRIBUTION: 11 (1).

Athelia teutoburgensis (Brinkmann) Jülich (1973).

Basidia 7.8-9.6 μm wide, basidiospores (7.8-) 9.6-12 x 4.6-6.2 μm .

HABITAT: on *Tamarix gallica* and unidentified hardwood. DISTRIBUTION: 2 (1), 6 (3).

Athelia sp.

Fig. 3

Coll. Losi 1283. Rather scanty specimen with effused, farinose to pellicular basidiome, whitish hymenial surface and subglobose basidiospores, 4.5-6.5 μm across; clamps not observed. *Athelia* sp. Hjortstam 5.3.1967 (Eriksson & Ryvarden, 1973) and *Athelia* sp. Duenas & Telleria (1985) could be closely related.

HABITAT: on *Alnus glutinosa*; DISTRIBUTION: 11 (1).

Botryobasidium candicans J. Erikss. (1958).

Anamorph: *Haplotrichum capitatum* (Link) Willd. (1824).

The anamorph is connected in 5 specimens and twice collected alone.

HABITAT: mostly on deciduous wood, sometimes on *Pinus*.

DISTRIBUTION: 2 (4), 4 (1), 7 (1), 8 (1), 11 (4), 13 (1), 23 (1), 26 (1).

Botryobasidium conspersum J. Erikss. (1958).

Anamorph: *Haplotrichum conspersum* (Link) Hol.-Jech. (1976).

The anamorph is connected in all the specimens and eight times collected alone.

HABITAT: associated with angiosperms. DISTRIBUTION: 1 (1), 2 (3), 8 (1), 11 (3).

Botryobasidium pruinatum (Bres.) J. Erikss. (1958).

Fig. 4

Coll. Losi 979 and 982 (Carpenedo Wood, 1.X.95, on *Carpinus betulus*): basidiome effused, hypochnoid to farinose, separable. Hymenial surface

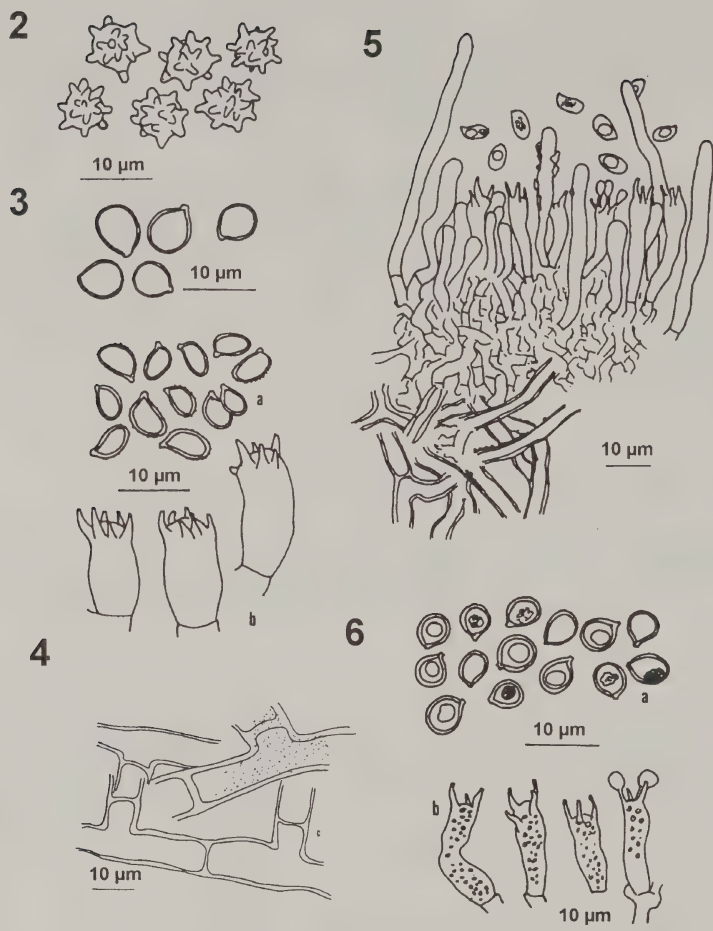


Fig. 2. *Asterostroma cervicolor* [Coll. Losi 1129]: basidiospores. Fig. 3. *Athelia* sp. [Coll. Losi 1283]: basidiospores. Fig. 4. *Botryobasidium pruinatum* [Coll. Losi 979]: a) basidiospores; b) basidia; c) subicular hyphae. Fig. 5. *Byssomerulius albostramineus* [Coll. Losi 1212]: basidiome section. Fig. 6. *Cristinia rhenana* [Coll. Losi 108]: a) basidiospores; b) basidia.

smooth, yellowish to pale yellowish grey or pale yellowish ochre; margin not particularly differentiated. Basal hyphae up to 15.2 µm in diam., rarely finely

asperulate. Basidia 6-sterigmate, 13.8-17.6 x 6.8-8.8 μm . Basidiospores obliquely ovoid to ellipsoid with thickened wall which under the light microscope at 1250x appear smooth to verruculose, 5.2-8 x 3.2-4.4 μm .

Coll. Losi 922 (Carpenedo Wood, 13.V.95, on *C. betulus*) and coll. Losi 323 (Carpenedo Wood, 10.V.94, on *C. betulus*): basidiome effused, byssoid to hypchnoid separable in small pieces. Hymenial surface smooth, yellowish to pale yellowish grey; margin not particularly differentiated. Basal hyphae up to 24 μm in diam., coarsely asperulate. Basidia 6-sterigmate, 16-23.2 x 6.8-8.2 μm . Basidiospores as in coll. 979 and 982, 5.2-8 x 3.2-4.8 μm . The first two described specimens differ from the last ones by having more narrow basal hyphae.

HABITAT and DISTRIBUTION: see the text.

Brevicellicium olivascens (Bres.) K.H. Larss. & Hjortstam (1978).

HABITAT: on various hardwoods. DISTRIBUTION: 3 (1), 4 (1), 5 (3), 7 (1), 8 (4), 9 (1), 11 (1), 13 (2), 14 (2), 19 (1).

Byssomerulius albostramineus (Torrend) Hjortstam (1987).

Fig. 5

Basidiome effused, membranaceous, separable. Hymenial surface white to pinkish, meruloid; margin arachnoid to hypchnoid, white to yellowish. Hyphae hyaline, simple-septate, thin- to slightly thick-walled, 1.8-5.6 μm in diam., rarely encrusted. Cystidia numerous, emerging, cylindrical, some sinuous, hyaline, thin-walled, sometimes with encrusting material, up to 60 μm long and 3.2-4.8 μm wide. Basidia clavate, 4-sterigmate, 18-25 x 4.4-5.6 μm . Basidiospores cylindrical to subballantoid, thin-walled, smooth, hyaline, with oildrops in the protoplasm, 3.6-5 x 1.8-2.4 μm .

HABITAT: on *Carpinus betulus*. DISTRIBUTION: 2 (1).

Byssomerulius corium (Pers.) Parmasto (1967).

HABITAT: on various hardwoods. DISTRIBUTION: 1 (1), 2 (2), 4 (2), 5 (4), 7 (1), 12 (1), 15 (1), 16 (1), 19 (2), 20 (1).

Chondrostereum purpureum (Pers.) Pouzar (1959).

HABITAT: on deciduous wood. DISTRIBUTION: 1 (2), 4 (3), 5 (2), 8 (1), 9 (1), 10 (1), 11 (18), 13 (2), 21 (1).

Coniophora arida (Fr.) P. Karst. (1868).

HABITAT: on decayed structural wood and cone of *Pinus pinea*. DISTRIBUTION: 11 (1), 24 (1).

Coniophora olivacea (Fr.) P. Karst. (1882).

HABITAT: on *Populus tremula*. DISTRIBUTION: 11 (1).

Coniophora puteana (Schumach.) P. Karst. (1868).

HABITAT: mostly on deciduous wood, sometimes on *Pinus*.

DISTRIBUTION: 1 (5), 2 (5), 5 (6), 6 (1), 7 (2), 8 (8), 11 (4), 12 (1), 13 (3), 15 (1), 25 (1), 30 (1).

Cristinia rhenana Grosse-Brauckmann (1993).

Fig. 6

Basidiome effused, farinose to membranaceous, separable in small pieces. Hymenial surface smooth to minutely tuberculate, whitish, whitish grey, whitish cream with pale yellowish tinges, hyphal strands few and towards the margin or abundant and richly branched on the whole surface; margin not particularly differentiated. Hyphal system monomitic; hyphae nodose-septate in subhymenium, clamps scattered in subiculum and nearly absent in cordons, hyaline, 2.5-6.4 μm in diam., thin- to slightly thick-walled; hyphal strands always numerous. Basidia subclavate, somewhat constricted, 20-30 x 5-7.2 μm , 4-sterigmate, with basal clamp. Basidiospores globose to ovoid or broadly asymmetrically ellipsoid, smooth, thick-walled, hyaline, mostly with one central oil drop in the protoplasm, 3.8-6.4 x 3.4-6 μm , cyanophilous, no reaction with Melzer's reagent. The hymenophore of *C. rhenana* normally (Hjortstam & Grosse-Brauckmann, 1993) should turn violet in KOH, not so in my collections, nevertheless it is the same taxon (Hjortstam, pers. comm.). HABITAT: on deciduous wood. DISTRIBUTION: 2 (4), 5 (5), 8 (5), 11 (7), 13 (1), 14 (1), 15 (1), 19 (1), 25 (2).

Crustoderma dryinum (Berk. & M.A. Curtis) Parmasto (1968).

Bright-coloured species with thick-walled hyphae of phlebioid aspect 1.8-5.8 μm in diam., numerous cystidia up to 140 μm long and 5.6-9.6 μm wide, narrowly clavate basidia 28-40 x 5.6-6.8 μm , subcylindrical to subballantoid basidiospores 6-10.4 x 2.8-4 μm .

HABITAT: on well decayed structural wood. DISTRIBUTION: 1 (1), 15 (2).

Cylindrobasidium evolvens (Fr.) Jülich (1974).

HABITAT: associated with angiosperms. DISTRIBUTION: 4 (6), 5 (4), 7 (3), 8 (1), 11 (1), 25 (1).

Erythricium hypnophilum (P. Karst.) J. Erikss. & Hjortstam (1970).

HABITAT: on *Tamarix gallica*. DISTRIBUTION: 8 (1).

Globulicium hiemale (Laurila) Hjortstam (1973).

Basidiospores 8-10 μm across.

HABITAT: on *Elaeagnus angustifolia*. DISTRIBUTION: 8 (3).

Gloiothele lactescens (Berk.) Hjortstam (1987).

HABITAT: on various hardwoods and decayed structural wood. DISTRIBUTION: 1 (1), 2 (11), 3 (1), 4 (18), 5 (5), 7 (4), 8 (2), 9 (1), 11 (9), 13 (3), 15 (1), 23 (1), 25 (1), 26 (1), 30 (1).

Hyphoderma argillaceum (Bres.) Donk (1957).

Basidiome effused, porose-hypochnoid to subceraceous. Hymenial surface yellowish brown, smooth to tuberculate; margin whitish, fibrillose or not particularly differentiated. Cystidia up to 70 μm long and 4.6-8 μm wide. Basidia clavate to somewhat constricted, 4-sterigmate, 19.2-24 x 4.8-5.6 μm . Basidiospores narrowly ellipsoid with oily inclusions in the protoplasm, 5.6-7.6

x 2.6-3.8 μm . *H. argillaceum* is considered a variable species (Eriksson & Ryvarden, 1975; Hjortstam & Larsson, 1995) and the two Venetian specimens have decidedly small cystidia, basidia and basidiospores.

HABITAT: on *Carpinus betulus*. DISTRIBUTION: 2 (2).

***Hyphoderma mutatum* (Peck) Donk (1957).**

Enclosed metuloids and enclosed or protruding gloecystidia equally frequent. Basidiospores 10.4-15.2 x 4-4.8 μm .

HABITAT: on deciduous wood. DISTRIBUTION: 11 (1), 25 (3).

***Hyphoderma praetermissum* (P. Karst.) J. Erikss. & Å. Strid (1975).**

HABITAT: on various hardwoods. DISTRIBUTION: 1 (2), 2 (10), 4 (5), 5 (4), 6 (2), 7 (3), 8 (14), 9 (7), 10 (1), 11 (35), 14 (1), 15 (1), 23 (1), 25 (1).

***Hyphoderma puberum* (Fr.) Wallr. (1833).**

Fig. 7

Lamprocystidia numerous, almost always of conical appearance. In collections on *Prunus avium* at Carbonera Island, several embedded or slightly projecting subulate gloecystidia present with homogeneous oily yellowish contents, apically sometimes surrounded by excreted amorphous masses of yellowish matter with adhering basidiospores; analogous amorphous yellow masses scattered here and there. Rare capitulate leptocystidia observed only in one specimen. Basidiospores cylindrical-ellipsoid to subballantoid, thin-walled, 8.2-11.2 (-12.6) x 4-4.8 (-5.2) μm , oily contents present in various quantities.

HABITAT: mostly on deciduous wood, sometimes on *Pinus* and decayed structural wood. DISTRIBUTION: 1 (8), 2 (2), 4 (1), 5 (3), 7 (2), 9 (1), 11 (8), 13 (5), 15 (4).

***Hyphoderma setigerum* (Fr.) Donk (1957).**

Fig. 8

Basidiome effused, membranaceous. Hymenial surface smooth to mostly graninioid, tuberculate or odontoid, white to yellowish or pale ochre; margin white, arachnoid to byssoid. Most of the collections microscopically typical: only septate cystidia present, basidia subclavate to subutriform, 4-sterigmate, 23.2-40 x 5.6-7.2 μm , basidiospores cylindrical-ellipsoid to subballantoid, thin-walled, smooth, with oily inclusions in the protoplasm, 9.6-13.2 x 3.6-5.2 μm . Coll. Losi 980 (Carpenedo Wood, 1.X.95, on *Cupressus sempervirens*) shows microscopical details quite similar to coll. Hagström 1974.08.24 (Eriksson & Ryvarden, 1975) with frequent septate cystidia, several smaller cylindrical projecting leptocystidia, numerous mostly enclosed gloecystidia widest at the base and few amorphous masses of yellowish matter; basidia 35-44 x 7.6-8.8 μm , basidiospores 9.6-12 x 4-5.2 μm . Coll. Losi 981 (Carpenedo Wood, 1.X.95, on unidentified wood) resembles very much the former but with equally numerous septate cystidia and leptocystidia, less frequent gloecystidia, smaller basidia 28-32.6 x 5.6-6.4 μm and slightly narrower basidiospores 9.6-12.8 x 3.4-4.4 μm .

HABITAT: preferably on deciduous wood, less often on conifers. DISTRIBUTION: 2 (6), 8 (1), 11 (7).

Hyphodermella corrugata (Fr.) J. Erikss. & Ryvarden (1976).HABITAT: on deciduous wood, canes of *Rubus* and herbaceous stems.

DISTRIBUTION: 4 (1), 5 (1), 6 (2), 7 (3), 8 (15), 9 (6), 11 (8), 23 (1).

Hyphodontia arguta (Fr.) J. Erikss. (1958).HABITAT: on various deciduous trees, *Pinus* spp., *Erianthus ravennae*, *Rubus* and decayed structural wood. DISTRIBUTION: 1 (3), 4 (5), 5 (8), 6 (3), 8 (24), 9 (6), 11 (20), 13 (6), 20 (1), 23 (1).**Hyphodontia aspera** (Fr.) J. Erikss. (1958).Basidiospores 4.4-5.6 x 3.4-4.8 μ m.HABITAT: on *Pinus* sp., *Elaeagnus angustifolia* and decayed structural wood.

DISTRIBUTION: 7 (1), 8 (1), 11 (2).

Hyphodontia breviseta (P. Karst.) J. Erikss. (1958).Basidiospores 4.2-5.6 x 3-3.4 μ m.HABITAT: on *Ulmus minor* and *Robinia pseudoacacia*. DISTRIBUTION: 5 (3).**Hyphodontia gossypina** (Parmasto) Hjortstam (1990).Basidiospores ellipsoid 4-5.6 x 2.8-4.2 μ m.HABITAT: on *Alnus glutinosa*. DISTRIBUTION: 11 (3).**Hyphodontia pallidula** (Bres.) J. Erikss. (1958).Cystidia with several clamps, up to 80 μ m long and 4-6.4 μ m wide; lagenocystidia not observed. Basidiospores ellipsoid 3.4-4.4 x 2.4-3.2 μ m.HABITAT: on structural wood and *Pinus* sp.. DISTRIBUTION: 2 (1), 15 (1).**Hyphodontia sambuci** (Pers.) J. Erikss. (1958).HABITAT: on deciduous and coniferous wood, floriferous cane of *Agave americana*, herbaceous stems. DISTRIBUTION: 1 (7), 2 (8), 3 (2), 4 (17), 5 (24), 6 (8), 7 (9), 8 (9), 9 (2), 10 (2), 11 (10), 13 (8), 14 (1), 15 (7), 19 (2), 29 (1), 23 (14), 26 (1), 27 (3), 30 (1).**Hypochnicium caucasicum** Parmasto (1967).Basidiospores broadly ellipsoid to subglobose, (5.5-) 6.4-7.2 (-8) x (5-) 5.6-6.4 (-7) μ m.

HABITAT: on deciduous wood. DISTRIBUTION: 1 (2), 2 (2), 3 (3), 4 (1).

Hypochnicium vellereum (Ellis & Cragin) Parmasto (1968).Basidiospores globose to subglobose (5-) 5.6-7.2 (-8) μ m across.

HABITAT: on deciduous wood. DISTRIBUTION: 2 (1), 3 (1), 5 (6), 10 (2).

Lagarobasidium detriticum (Bourdot) Jülich (1979).Recently re-considered in the genus *Hyphodontia* by Hjortstam (1988).Cystidia frequent, up to 115 μ m long and 4.8-9.4 μ m wide towards the apex.Basidiospores ellipsoid 4.2-5.8 x 3.6-4.2 μ m.HABITAT: on dead branch of *Pinus* sp., on *Erianthus ravennae*.

DISTRIBUTION: 9 (1), 11 (1).

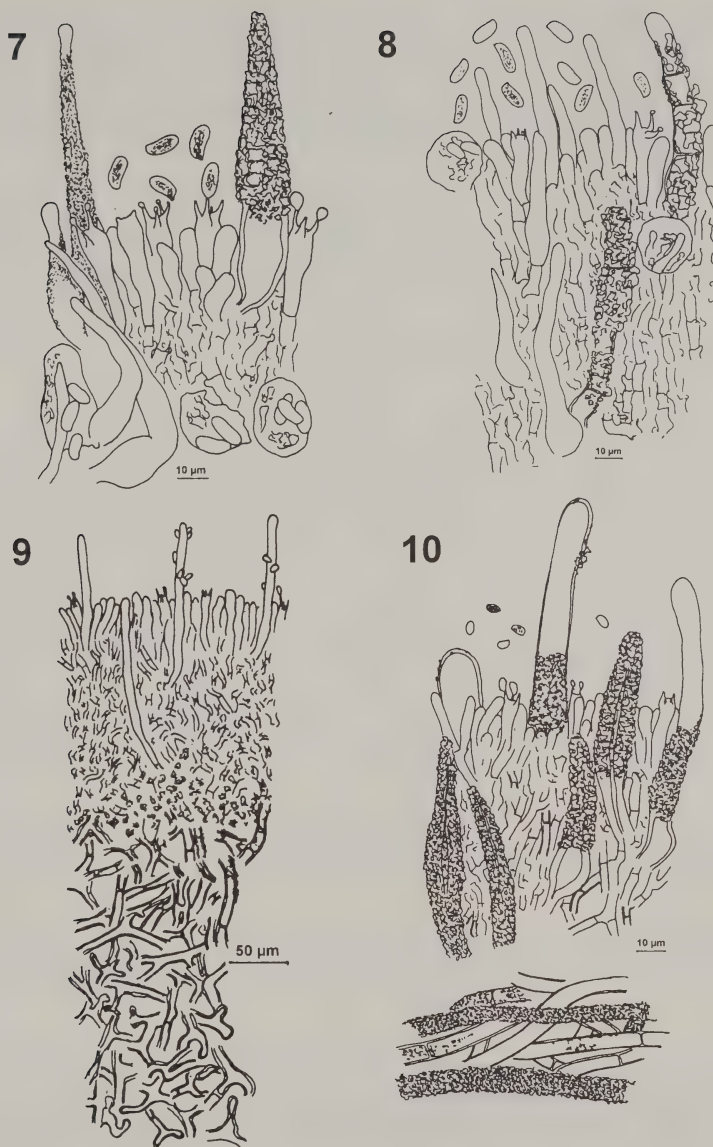


Fig. 7. *Hyphoderma puberum* [Coll. Losi 1121]: basidiome section.

Fig. 8. *Hyphoderma setigerum* [Coll. Losi 980]: basidiome section.

Fig. 9. *Phanerochaete magnoliae* [Coll. Losi 948]: basidiome section.

Fig. 10. *Phanerochaete velutina* [Coll. Losi 1090]: basidiome section.

Leucogyrophana mollusca (Fr.) Pouzar (1958).

Hymenial surface meruloid, at first whitish to pale yellow, then orange yellow to orange; margin white, arachnoid or fibrillose-byssoid. Basidiospores ellipsoid, $5.2-6.4 \times 3.8-4.8 \mu\text{m}$, not or slightly dextrinoid.

HABITAT: on strongly decayed structural wood. DISTRIBUTION: 15 (2).

Lindtneria leucobryophila (Henn.) Jülich (1977).

Basidiome effused, membranaceous, separable. Hymenial surface whitish with scattered pale yellow areas, smooth to granuloid; margin arachnoid, fibrillose or not particularly differentiated. Hyphae nodose-septate, simple septa very rare; basidia with basal clamp. Basidiospores ellipsoid, densely spinulose, $5.4-8 \times 4.4-5.2 \mu\text{m}$.

HABITAT: on *Ulmus minor*. DISTRIBUTION: 5 (1).

Lindtneria panphylensis Bernicchia & M.J. Larsen (1990).

Basidiome effused, pellicular to membranaceous, separable. Hymenial surface yellow, tuberculate to hydroid; margin arachnoid, whitish to yellowish. Hyphae mostly simple-septate; basidia without basal clamp. Basidiospores ellipsoid to fusoid, with irregularly distributed warts, $6.4-10.4 \times 4-5.6 \mu\text{m}$.

HABITAT: on *Ulmus minor* and *Elaeagnus angustifolia*. DISTRIBUTION: 5 (1), 8 (1).

Litschauerella clematitis (Bourdot & Galzin) J. Erikss. & Ryvarden (1976).

Basidiome effused, rather pulverulent with smooth, white to pale greyish hymenial surface. Cystidia up to $150 \mu\text{m}$ long and $12-20 \mu\text{m}$ wide. Basidiospores globose to subglobose $7-10 \mu\text{m}$ across. Hyphal side-branches with apical encrustation and mature basidia not observed.

HABITAT: on *Pinus sp.*. DISTRIBUTION: 9 (1).

Meruliopsis taxicola (Pers.) Bondartsev (1959).

HABITAT: on unidentified wood. DISTRIBUTION: 2 (1).

Mycoacia aurea (Fr.) J. Erikss. & Ryvarden (1976).

HABITAT: on *Carpinus betulus* and *Alnus glutinosa*. DISTRIBUTION: 2 (2), 11 (1).

Mycoacia nothofagi (G. Cunn.) Ryvarden (1981).

Basidiome effused, ceraceous, separable in pieces. Hymenial surface white to cream or pale ochre, then deep brown, hydroid to somewhat irpicoid with aculei up to 2.5 mm long; margin white fimbriate or not particularly differentiated. Smell sometimes as in *Antrodia xantha* (Fr.) Ryvarden. Basidiospores cylindrical-ellipsoid to subballantoid, $4.2-5.6 \times 2.4-2.8 \mu\text{m}$. Coll. Losi 1225 has shorter aculei, up to 0.5 mm long, smaller cystidia and basidiospores $3.4-4.4 \times 1.6-2 \mu\text{m}$.

HABITAT: on deciduous wood. DISTRIBUTION: 1 (3), 2 (1), 9 (1).

Mycoaciella bispora (Stalpers) J. Erikss. & Ryvarden (1978).

Basidiome effused, ceraceous. Hymenial surface cream to brownish or greenish, hydroid with dense conical aculei up to 5 mm long and 0.4 mm wide, sometimes basally joined or apically divided, seldom penicillate; smooth hymenium between aculei pale greyish to cream, visible only at first towards the margin when aculei are small and sparse. Margin not particularly differentiated. Subiculum thin. Hyphal system dimitic; generative hyphae nodose-septate. Skeletal hyphae only present in the aculeal trama, parallelly packed, sometimes encrusted, thick-walled, with several adventitious septa, 2.4-5 μm wide. Subicular hyphae rather densely interwoven, irregular, up to 5.6 μm wide, thin- to thick-walled. Subhymenial hyphae densely interwoven, strongly irregular, thin-walled, up to 4 μm wide. Cystidia numerous, slightly projecting, cylindrical (hyphoid appearance), thin-walled, mostly surrounded by a resinous cap (this latter not observed in coll. Losi 1335), 26-44 x 4-5.6 μm . Basidia narrowly clavate, 4-sterigmate, 19.2-32 x 4.4-5.6 μm . Basidiospores narrowly ellipsoid to suballantoid, thin-walled, with oil drops in the protoplasm, 4.4-6.6 x 2.4-3.2 μm . The closest relative of *M. bispora* is *M. hinnulea* (Bres.) Hjortstam & Ryvarden and the larger basidiospores of the latter (6-7 x 3.5 μm vs. 4-5.5 (-6) x 2.5-3 μm) seem to be the only reliable distinguishing characteristic (Hjortstam & Ryvarden, 1980). The specimens in question are characterized by the somewhat intermediate size of the basidiospores, larger cystidia and basidia and macroscopically by the longer aculei.

HABITAT: on deciduous wood. DISTRIBUTION: 2 (1), 4 (1), 11 (1).

Peniophora cinerea (Pers.) Cooke (1879).

Basidiospores 6.8-8.4 x 3-3.2 μm .

HABITAT: on deciduous wood. DISTRIBUTION: 11 (3), 12 (1), 25 (1).

Peniophora incarnata (Pers.) P. Karst. (1889).

HABITAT: on deciduous wood. DISTRIBUTION: 1 (1), 2 (1), 3 (1), 4 (6), 8 (3), 11 (2), 15 (1), 17 (1), 25 (1).

Peniophora laeta (Fr.) Donk (1957).

Basidiospores 9.6-12 x 3.6-4.6 μm .

HABITAT: on *Carpinus betulus*. DISTRIBUTION: 4 (1).

Peniophora lycii (Pers.) Höhn. & Litsch. (1907).

Basidiospores 8-11.2 x 3.2-4.8 μm .

HABITAT: on various hardwoods and *Rubus*. DISTRIBUTION: 1 (1), 2 (3), 3 (2), 4 (4), 5 (10), 6 (3), 7 (2), 8 (5), 9 (2), 10 (1), 11 (8), 13 (2), 14 (1), 15 (1), 23 (1).

Peniophora nuda (Fr.) Bres. (1897).

Basidiospores 8.4-11.2 x 3.2-3.8 μm .

HABITAT: on *Carpinus betulus*. DISTRIBUTION: 2 (1).

Peniophora quercina (Pers.) Cooke (1879).

HABITAT: on *Quercus*. DISTRIBUTION: 1 (1), 2 (1), 4 (1), 9 (1).

Peniophora tamaricicola Boidin & Malencon (1961).

HABITAT: on *Tamarix gallica*. DISTRIBUTION: 5 (4), 6 (1), 8 (9), 14 (1), 18 (1).

Phanerochaete aculeata Hallenb. (1978).

Basidiome effused, ceraceous to subceraceous, separable. Hymenial surface whitish to pale ochre, odontoid to hydroid or sometimes irpicoid with aculei up to 3 mm long; margin arachnoid or not particularly differentiated. Subhymenial hyphae densely interwoven, thin-walled, 1.6-3.2 μm wide; tramal hyphae parallelly packed, thick-walled, 2.4-5.6 μm wide; subicular hyphae distinct, branched at nearly right angles in all directions, thick-walled, 3.2-9.6 μm wide; clamps not observed. Crystalline material often present in the trama and subiculum. Cystidia few to frequent, projecting, cylindrical, somewhat constricted, thin- to slightly thick-walled, with scattered crystalline encrusting material, 46-80 x 4-7.8 μm . Basidia narrowly clavate, 4-sterigmate, 19-28 x 4-4.8 μm . Basidiospores cylindrical-ellipsoid, adaxially flattened or slightly subballantoid, 4-5.6 x 2-2.6 μm .

HABITAT: on deciduous trees and decayed structural wood. DISTRIBUTION: 2 (5), 5 (2), 7 (1), 8 (1), 11 (1).

Phanerochaete deflectens (P. Karst.) Hjortstam (1987).

Hymenial surface smooth to tuberculate. Cystidia not observed; basidiospores 4-5.2 x 2-2.7 μm . Specimen close to *P. lutea* (Sheng-Hua Wu) Hjortstam (Sheng-Hua Wu, pers. comm.).

HABITAT: on unidentified hardwood. DISTRIBUTION: 7 (1).

Phanerochaete magnoliae (Berk. & M.A. Curtis) Burds. (1985). Fig. 9

Basidiome effused, subceraceous, not separable. Hymenial surface whitish cream to brownish, brownish orange, sometimes with a faint pinkish tinge, smooth to tuberculate; margin white, arachnoid- to byssoid-fibrillose. Subhymenial hyphae densely interwoven, thin- to slightly thick-walled, 1.8-3.2 μm wide; subicular hyphae distinct, 3-7.2 μm in diam., thick-walled, mostly with numerous ramifications and short branches like binding hyphae, sometimes with encrusting crystalline material which is particularly abundant towards the subhymenium; clamps not observed. Cystidia frequent, usually projecting, cylindrical, slightly thick-walled except in the distal part, not encrusted or rarely with scattered crystals, 68-100 (-120) x 4.8-7 μm . Basidia narrowly clavate to clavate, 4-sterigmate, 20.8-37.2 x 4.6-5.6 μm . Basidiospores cylindrical-ellipsoid, adaxially flattened or slightly concave, with oily contents, 5.2-6.8 x 2.6-3.2 μm . Coll. Losi 1311 (Ca' Savio Wood on *Alnus glutinosa*) differs in having a whitish cream, tuberculate to odontoid hymenial surface with aculei up to 500 μm long and subicular hyphae with occasional short branches. It seems to be a deviating form of *P. sordida* rather than *P. magnoliae*, on the other hand it would be possible that *P. magnoliae* and *P. sordida* intergrade.

HABITAT: on *Alnus glutinosa*. DISTRIBUTION: 11 (2).

Phanerochaete martelliana (Bres.) J. Erikss. & Ryvarden (1978).

Basidiome effused, ceraceous. Hymenial surface cream to ochre or reddish ochre, smooth; margin not differentiated or fibrillose- byssoid. Subhymenial hyphae vertical with compact texture, thin- to slightly thick-walled, 4-7.2 µm wide. Subicular hyphae sparsely branched into a loose texture, slightly thick-walled, 4-8 µm wide. Clamps not observed. Cystidia few to frequent, projecting, nearly cylindrical or fusiform, thin-walled towards the apex and slightly thick-walled elsewhere, naked or very rarely with scattered crystals, some adventitious septa may be present, up to 100 µm long and 6.4-8.8 µm wide. Basidia subclavate, 4-sterigmate, 28-44 x 7.2-8.8 µm; the basidial protoplasm contains a number of small oil drops. Basidiospores cylindrical-ellipsoid, adaxially flattened or slightly concave, with oily inclusions in the protoplasm, 8.8-12.6 (-13.6) x 4.6-5.8 (-6.2) µm. Voucher specimens: Losi 1379 and 1380, Caroman Wood, on *Tamarix gallica*. Coll. Losi 905 (Caroman Wood, on *T. gallica*) and coll. Losi 1116 (Carbonera Island, on *T. gallica*) differ by having smaller cystidia (46-80 x 6-7.2 µm) and basidiospores (8-9.6 x 4.6-5.6 µm). Specimens collected in Cassa di Colmata B on *T. gallica* (Losi 1192, 1377 and 1378) are characterized by the size of basidiospores (7.2-10 x 3.4-4.2 µm) and cystidia (60-140 x 5.6-9.6 µm). Coll. Losi 1233 (Valle Averte, on *T. gallica*) has basidiospores 7.2-9.8 x 3.4-4 µm and rare, apically encrusted, ca. 50 µm long cystidia. Coll. 1192, 1377 and 1378 could be close to *P. tamariciphila* Boidin, Lanquetin & Gilles because of the size of basidiospores but this latter species has smaller cystidia. More closely related to *P. tamariciphila* seems to be coll. 1233. However among Venetian collections there is no relation between size of cystidia and basidiospores and I do not consider the variation of these latter sufficient for specific separation. On the other hand the size of basidiospores seems to intergrade (see specimens 905 and 1116).

HABITAT and DISTRIBUTION: see the text.

Phanerochaete ca. pallidovirens (Bourdot & Galzin) Hjortstam (1987).

Basidiome effused, subceraceous. Hymenial surface whitish, smooth; margin fibrillose-fimbriate to arachnoid or not differentiated. Basidiospore size (5.5-6.5 x 3.2-3.8 µm) fit that of the type specimen but subiculum is more like type specimen of *P. cremeo-ochracea* (Bourdot & Galzin) Hjortstam (Sheng-Hua Wu, pers. comm.).

HABITAT: on unidentified hardwood. DISTRIBUTION: 1 (1).

Phanerochaete parvispora Sheng-Hua Wu & Losi (1995).

HABITAT: on *Alnus glutinosa*. DISTRIBUTION: 11 (1).

Phanerochaete sordida (P. Karst.) J. Erikss. & Ryvarden (1978).

The following description refers to examples typical of this species. Basidiome effused, membranaceous to subceraceous, not separable. Hymenial surface whitish to cream, smooth; margin not particularly differentiated or white and byssoid-fibrillose. Subhymenial hyphae vertical in a compact texture, thin- to slightly thick-walled, 2.4-4.6 µm wide; subicular hyphae distinct in a loose texture, mostly branched at right angles, thick-walled (on the average 1.6 µm),

sometimes irregularly encrusted, 4-8.8 μm wide. Cystidia usually frequent, projecting, cylindrical-fusiform, at first naked and thin-walled, then apically coarsely encrusted with crystalline material and thick-walled, 50-90 x 5.6-9.6 μm . Basidia narrowly clavate, 4-sterigmate, 20-32 x 4.2-5.6 μm . Basidiospores cylindrical-ellipsoid, adaxially flattened or slightly concave, with oily contents, 5.2-7.2 x 2.4-3.2 μm . Deviating specimen coll. Losi 1334 with cream to brownish orange hymenial surface and naked thick-walled cylindrical-fusiform cystidia. See further *P. magnoliae*.

HABITAT: on deciduous wood. DISTRIBUTION: 2 (6), 4 (1), 5 (10), 6 (1), 8 (5), 11 (30), 13 (1), 17 (1).

***Phanerochaete subquercina* (Henn.) Hjortstam (1987).**

Basidiome effused, ceraceous. Hymenial surface at first whitish, pale yellow or cream then brownish, odontoid with mostly dense, conical or cylindrical aculei up to 2 mm long, sometimes joined in small groups, at the apex frequently penicillate, less often bifurcate; margin whitish byssoid or not differentiated. Subhymenial hyphae densely interwoven, thin- to slightly thick-walled, 2.4-3.2 μm wide; tramal hyphae parallelly packed, anastomoses frequent, slightly thick-walled, thin-walled in apices of aculei, 2.4-5 μm wide; subicular hyphae thick-walled, 4-8 μm wide, subparallel with rather dense texture to the substrate, more irregularly interwoven elsewhere in a loose texture. On the other hand the subiculum is often scanty, with dense texture and slightly thick-walled sometimes conglutinated hyphae; no clamps observed. Basidia subclavate, 4-sterigmate, 20-32 x 4.8-6.2 μm . Basidiospores narrowly ellipsoid, adaxially flattened or slightly concave, rarely ellipsoid-obovate, 4.8-6.4 (-7.2) x 2.8-3.6 (-4) μm .

HABITAT: on deciduous wood. DISTRIBUTION: 8 (1), 11 (3), 12 (1), 13 (2).

***Phanerochaete tuberculata* (P. Karst.) Parmasto (1968).**

Basidiome effused, membranaceous, not separable. Hymenial surface whitish to cream or pale ochre, smooth to tuberculate, in older states cracked; margin white, arachnoid-fibrillose, fibrillose-fimbriate or cordonic. Subhymenial hyphae fairly vertical in a compact texture, thin- to slightly thick-walled, 2.4-5.6 μm wide; subicular hyphae horizontal towards the substratum in a textura porrecta, densely interwoven elsewhere, slightly thick-walled, 3.2-8 μm wide. Clamps not observed. Basidia narrowly clavate to clavate, 4-sterigmate, 24-36 x 5.2-7.2 μm . Basidiospores ellipsoid, with oil drops, 5.6-7.2 x 3.8-4.4 μm .

HABITAT: on hard wood. DISTRIBUTION: 2 (3), 6 (1), 11 (1).

***Phanerochaete velutina* (DC.) P. Karst. (1898).**

Fig. 10

Basidiome effused, subceraceous, adherent. Hymenial surface brownish orange to brownish pink, smooth; margin white, fimbriate. Subhymenial hyphae thin- to slightly thick-walled, 2.6-5.6 μm in diam.; subicular hyphae slightly thick-walled, often encrusted, 4-9.6 μm in diam.; some clamps present in subiculum. Cystidia abundant, cylindrical to conical, thick-walled, encrusted, up to 160 μm long and 8-14 μm wide. Basidia narrowly clavate, 4-sterigmate, 28-42 x 5.2-7.2 μm . Basidiospores narrowly ellipsoid to suballantoid, thin-walled, 5.2-6.8 x 3-3.4 μm . Coll. Losi 1090 with cream to pale brown hymenial

surface and cordonic margin has smaller basidiospores (4-5.2 x 2.4-3.2 μm) and cystidia which very much resemble those of *Scopuloides leprosa* (Bourdot & Galzin) Boidin, Lanquetin & Gilles; subicular and subhymenial hyphal arrangement is nevertheless typical of *P. velutina*.

HABITAT: on deciduous wood. DISTRIBUTION: 2 (3), 4 (2), 11 (1).

Phlebia chrysocreas (Berk. & M.A. Curtis) Burds. (1965).

Basidiome effused, ceraceous. Hymenial surface yellowish brown with orange and pinkish tints, smooth to tuberculate or even odontoid; margin not differentiated.

HABITAT: on *Prunus avium*. DISTRIBUTION: 13 (1).

Phlebia radiata Fr. (1821).

HABITAT: on deciduous wood. DISTRIBUTION: 8 (1), 9 (1), 11 (5).

Phlebia rufa (Pers.) M.P. Christ. (1960).

HABITAT: on deciduous wood. DISTRIBUTION: 1 (1), 2 (6), 3 (1), 8 (1), 10 (1), 11 (4).

Phlebia tremellosa (Schrad.) Nakasone & Burds. (1984).

HABITAT: on deciduous wood. DISTRIBUTION: 2 (3).

Phlebiella sulphurea (Pers.) Ginns & Lefebvre (1993).

HABITAT: on *Carpinus betulus*. DISTRIBUTION: 2 (1).

Phlebiella tulasnelloidea (Höhn. & Litsch.) Bondartsev & Singer (1953).

HABITAT: on *Alnus glutinosa* and *Pinus* sp.. DISTRIBUTION: 11 (6).

Porostereum spadiceum (Pers.) Hjortstam & Ryvarden (1990).

HABITAT: on *Elaeagnus angustifolia*, *Robinia pseudoacacia* and *Populus* spp.. DISTRIBUTION: 2 (3), 3 (1), 5 (2), 8 (9), 9 (3), 11 (10), 22 (1).

Radulomyces confluens (Fr.) M.P. Christ. (1960).

HABITAT: mostly on deciduous wood but may also occur on *Pinus* spp. and decayed structural wood. DISTRIBUTION: 1 (14), 2 (5), 4 (7), 5 (22), 6 (2), 7 (1), 8 (24), 9 (6), 10 (1), 11 (7), 13 (6), 14 (1), 15 (3), 16 (1), 19 (1), 23 (3), 25 (2), 28 (1), 30 (3).

Radulomyces molaris (Chaillet) M.P. Christ. (1960).

HABITAT: on deciduous wood. DISTRIBUTION: 2 (14), 5 (1), 8 (3), 13 (3).

Scopuloides rimosa (Cooke) Jülich (1982).

Basidiome effused, ceraceous, not separable. Hymenial surface greyish with bluish and brownish tinges, minutely odontoid; aculei sparse or abundant, cylindrical to less frequently attenuate, with obtuse fimbriate apices. Margin white, fimbriate.

Basidiospores suballantoid, 3.8-4.5 x 1.5-2 μm .

HABITAT: on *Carpinus betulus*. DISTRIBUTION: 2 (3).

Scytinostroma portentosum (Berk. & M.A. Curtis) Donk (1956).

HABITAT: on deciduous wood. DISTRIBUTION: 8 (1), 9 (1), 30 (1).

Scytinostromella olivaceoalba (Bourdot & Galzin) Ginns & Lefebvre (1993).

Recently transferred to the genus *Amylocorticium* by Boidin et al. (1997).

HABITAT: on *Pinus pinea*. DISTRIBUTION: 11 (1).

Sistotrema brinkmannii (Bres.) J. Erikss. (1948).

HABITAT: on deciduous trees and burnt wood of *Pinus pinea*.

DISTRIBUTION: 1 (3), 2 (1), 5 (2), 7 (1), 8 (1), 13 (2), 16 (1).

Sistotrema efibulatum (J. Erikss.) Hjortstam (1984).

HABITAT: on unidentified wood. DISTRIBUTION: 4 (1).

Sistotrema oblongisporum M.P. Christ. & Hauerslev (1960).

HABITAT: on unidentified hardwood and *Pinus pinea*. DISTRIBUTION: 7 (1), 8 (1).

Sistotrema octosporum (J. Schröt. ex Höhn. & Litsch.) Hallenb. (1984).

HABITAT: on *Populus alba* and *Carpinus betulus*. DISTRIBUTION: 2 (3), 8 (1).

Sistotrema resinicystidiatum Hallenb. (1980).

HABITAT: on deciduous wood. DISTRIBUTION: 1 (2), 2 (2).

Sistotremella hauerslevii Hjortstam (1984).

Basidiome effused, thin, ceraceous. Hymenial surface white to pale greyish, smooth to graninoid; margin not differentiated. Hyphae simple-septate, thin to slightly thick-walled, often with oily granular contents, 2.4-4.8 μm wide, frequently joined together in hyphal strings. Gloeocystidia numerous. Basidia urniform, with 6-8 sterigmata. Basidiospores ellipsoid, thick-walled, 3.8-4.2 x 2.4-3.2 μm .

HABITAT: on *Ailanthus altissima*. DISTRIBUTION: 15 (1).

Sistotremella perpusilla Hjortstam (1984).

Basidiome effused, thin, subceraceous. Hymenial surface white to pale greyish, smooth; margin not differentiated. Hyphae nodose-septate, 1.6-3.2 μm wide. Basidia urniform, with 6-8 sterigmata, 11.2-17.6 x 4-4.8 μm . Basidiospores ellipsoid to broadly ellipsoid, thick-walled, 3.6-4 x 2.6-3.2 μm .

HABITAT: on strongly decayed wood of *Prunus avium*. DISTRIBUTION: 13 (1).

Steccherinum bourdotii Saliba & David (1988).

Basidiospores 4-4.8 x 3.2-4.2 μm .

HABITAT: on deciduous wood. DISTRIBUTION: 1 (6), 2 (4), 3 (2), 4 (2), 11 (8).

Steccherinum fimbriatum (Pers.) J. Erikss. (1958).

HABITAT: on unidentified hardwood. DISTRIBUTION: 1 (1).

Steccherinum ochraceum (Pers. ex J.F. Gmel.) Gray (1821).

HABITAT: on various hardwoods. DISTRIBUTION: 1 (3), 2 (4), 6 (1), 8 (2), 9 (1), 11 (22), 12 (1).

Stereum hirsutum (Willd.) Gray (1821).

HABITAT: on deciduous wood. DISTRIBUTION: 1 (5), 2 (30), 4 (8), 5 (4), 6 (1), 8 (10), 11 (7), 29 (1).

Subulicium lautum (H.S. Jacks.) Hjortstam & Ryvarden (1979).

Basidiome effused, inconspicuous, somewhat pellicular. Hymenial surface whitish to greyish white, smooth; margin not differentiated. Hyphae simple-septate, thin- to slightly thick-walled, 3-6.4 μm wide. Cystidia numerous, subulate, mostly lateral, thick-walled, up to 120 μm long and 10 μm wide at the base. Basidiospores subglobose, slightly thick-walled, 6.8-8.8 x 6.4-7.8 μm .

HABITAT: on *Alnus glutinosa*. DISTRIBUTION: 11 (1).

Subulicystidium longisporum (Pat.) Parmasto (1968).

HABITAT: on deciduous wood. DISTRIBUTION: 1 (3), 2 (3), 3 (1), 4 (1), 5 (3), 7 (1), 8 (4), 9 (2), 10 (2).

Terana caerulea (Lam.) Kuntze (1891).

HABITAT: on *Pinus*. DISTRIBUTION: 4 (1), 9 (1).

Trechispora alnicola (Bourdot & Galzin) Liberta (1966).

HABITAT: on deciduous wood. DISTRIBUTION: 2 (16), 8 (1), 11 (1).

Trechispora cohaerens (Schwein.) Jülich & Stalpers (1980).

HABITAT: on deciduous trees, cones and needles of *Pinus pinaster*, old hymenial surface of *Phellinus punctatus*. DISTRIBUTION: 2 (3), 5 (1), 8 (5), 30 (1).

Trechispora farinacea (Pers.) Liberta (1966).

HABITAT: on various hardwoods and decayed structural wood. DISTRIBUTION: 2 (2), 6 (1), 8 (4), 9 (1), 11 (1), 14 (1), 15 (1), 23 (1).

Trechispora microspora (P. Karst.) Liberta (1966).

HABITAT: on unidentified deciduous wood. DISTRIBUTION: 1 (1).

Trechispora nivea (Pers.) K.H. Larss. (1995).

HABITAT: on deciduous trees and decayed structural wood. DISTRIBUTION: 1 (1), 2 (1), 4 (1), 8 (2), 9 (1), 15 (2).

Tubulicrinis calothrix (Pat.) Donk (1956).

Basidiospores 5.6-8 x 1.6-2.2 (-2.4) μm .

HABITAT: on decayed structural wood. DISTRIBUTION: 15 (1).

Vuilleminia comedens (Nees) Maire (1902).

HABITAT: on deciduous wood. DISTRIBUTION: 2 (2), 11 (3).

Xenasma pulverulentum (Litsch.) Donk (1957).

Basidiospores 6.8-9.2 x 4.8-5.6 μ m.

HABITAT: on *Ulmus minor*. DISTRIBUTION: 5 (1).

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TWO NEW SPECIES OF XANTHOPARMELIA (ASCOMYCOTINA, PARMELIACEAE) FROM AUSTRALASIA

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ABSTRACT: *Xanthoparmelia isidiotegeta* Elix & Kantvilas from Australia and New Zealand, and *X. stanthorpensis* Elix & Kantvilas from Australia are described as new to science.

Introduction

As a result of a continuing study of the lichen genus *Xanthoparmelia* in Australasia (Elix 1994, 1997a,b; Kantvilas & Elix 1995), we are describing a further two new species. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson *et al.* 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993; Elix *et al.* 1988), high performance liquid chromatography (Feige *et al.* 1993) and comparison with authentic samples.

***Xanthoparmelia isidiotegeta* Elix & Kantvilas, sp. nov.**

Fig. 1

Species cum thallo ut in *Xanthoparmelia tegeta* sed ab hac specie lobis isidiatibus differt.

Type: AUSTRALIA. Tasmania, dolerite cliffs at summit of Mt Direction, 42°49'S, 147°19'E, 441 m, on sheltered rock ledges, G. C. Bratt 72/644, 8 July 1972; holotype: HO.

Thallus small-foliose to foliose, moderately adnate to adnate, to 3-6 cm wide. *Lobes* imbricate, sublinear to sublinear-elongate, subirregularly to dichotomously branched, 0.2-1.2 mm wide. *Upper surface* pale yellowish green, mostly flat, shiny, emaculate, smooth, lacking soredia; lobe margins



Figures 1-2. New species of *Xanthoparmelia*: 1, *X. isidiotegeta* (Elix 7381 in CANB); 2, *X. stanthorpensis* (holotype in CANB). Scale bar = 5 mm.

often blackening near apices, sometimes appearing ciliate; isidia moderately dense, cylindrical, simple or branched and becoming coralloid, with apices syncorticate and intact, $\pm$ blackening. *Medulla* white. *Lower surface* black; rhizines moderately dense, $\pm$ projecting beyond margins and resembling cilia, simple or rarely dichotomously branched, to 2 mm long, black. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-; medulla K+ yellow, C-, KC-, P+ orange-red; containing usnic acid (major), stictic acid (major), constictic acid (minor), cryptostictic acid (minor/trace), norstictic acid (minor).

This species is characterized by the moderately adnate, small-foliose to foliose thallus, the narrow, imbricate lobes with a black lower surface, the presence of cylindrical isidia and stictic acid in the medulla. In overall morphology this species closely resembles *Xanthoparmelia tegeta* Elix & J. Johnst., but the latter species is more densely imbricate and lacks isidia. *Xanthoparmelia isidiotegeta* could be confused with the chemically identical, isidiate species *Xanthoparmelia phillipsiana* (Filson) Elix & J. Johnst., but the latter species is distinguished by having a more tightly adnate thallus, contiguous, non-imbricate linear lobes, with a weakly convex, partially maculate upper surface. Also closely related is the very common and widespread species, *X. mougeotina* (Nyl.) D. Galloway, which differs in being much more tightly adnate to subcrustose, and in having radiating, mostly non-overlapping lobes that form rather neat rosettes and lack conspicuous, marginally protruding rhizines.

At present this species is known from Victoria, Tasmania and the south island of New Zealand. It appears to be rather uncommon, and the widely scattered localities known currently suggest that it favours cool, moist habitats.

Specimens Examined

AUSTRALIA. Tasmania, ca. 16 km N of Tullah on Murchison Highway, 41°37'S, 145°39'E, 660 m, on quartzite rocks, G. C. Bratt & M. H. Bratt 72/166a, b, c, 2 April 1972 (HO); Woods Quoin, 42°17'S, 147°05'E, 1000 m, on exposed dolerite rocks, G. C. Bratt & J. A. Cashin 72/372, 17 June 1972 (HO); type locality, on sheltered dolerite rocks, G. C. Bratt 72/643, 8 July 1972 (HO); Mt Cameron, N slope, 6 km WSW of Gladstone, 40°59'S, 147°56'E, 450 m, on granite rocks in *Eucalyptus* woodland, J. A. Elix 42601, 22 April 1997 (CANB). Victoria, Mt Torbreck, 37°22'S, 145°56'E, 1450 m, on granite rocks, J. Sago s.n., 19 April 1997 (CANB).

NEW ZEALAND. Westland, Denniston Plateau, 3.5 km S of Denniston township, 660 m, on exposed sandstone in boggy heath, J. A. Elix 7381, 27 Feb. 1980 (CANB).

Xanthoparmelia stanthorpensis Elix & Kantvilas, sp. nov.

Fig. 2

Species cum thallo ut in *Xanthoparmelia barbatica* sed ab hac specie laxe adnato, lobis sublinearibus et acido diffractaico continente differt.

Type: AUSTRALIA. Queensland, Paling Yard Creek, 21 km ESE of Stanthorpe, 28°50'S, 151°59'E, 1000 m, on granite rocks at margin of grazed area and wet sclerophyll forest, J. A. Elix 35786, 6 Sept. 1993; holo: CANB.

Thallus foliose, loosely adnate to adnate, to 4-7 cm wide. Lobes imbricate or not, radiating, flat becoming sublinear to subirregular, irregularly branched, 1-3 mm wide, developing sublinear-elongate laciniae, 0.7-1.5 mm wide; apices of the marginal lobes subrotund. *Upper surface* yellow-green, dull in centre but shiny at lobe apices, emaculate, with transverse or irregular cracks, without isidia or soredia. *Medulla* white. *Lower surface* ± dull, smooth, pale tan to dark brown; rhizines moderately dense, simple, 0.3-0.5 mm long, concolorous or becoming darker. *Apothecia* common, sessile or shortly pedicellate, 0.7-3.5 mm wide; disc concave at first, becoming ± flat or undulate, dark brown; thalline exciple smooth, thick, involute, becoming thin and slightly lacerate. *Ascospores* ellipsoidal, 8-10 × 4-6 µm. *Pycnidia* common, immersed. *Conidia* bifusiform, 6-7 × 0.7-1 µm.

Chemistry. Cortex K-; medulla K-, C-, KC-, P-; containing usnic acid (minor), diffractaic acid (major), barbatic acid (trace), 4-O-demethylbarbatic acid (trace).

This species is characterized by the foliose thallus, the pale lower surface, the absence of isidia, and the presence of diffractaic acid in the medulla. *Xanthoparmelia stanthorpensis* resembles *X. barbatica* (Elix) Egan as both lack isidia, have marginal lobes with rotund apices, develop narrower, sublinear-elongate laciniae, and have a pale lower surface. However, *X. stanthorpensis* has a loosely to moderately adnate thallus, imbricate, sublinear to subirregular lobes and contains diffractaic acid whereas *X. barbatica* has a tightly adnate thallus, irregular lobes and contains barbatic and dehydroconstipatic acids. This endemic Australian species seems to be rare on rocks in the Great Dividing Range in southern Queensland, in the vicinity of Stanthorpe.

Specimens Examined

AUSTRALIA. Queensland, Eukey-Wyberba road, 19 km ESE of Stanthorpe, 28°49'S, 151°59'E, 1000 m, on granite rocks in dry sclerophyll forest, J. A. Elix 35725, 6 Sept. 1993 (CANB); type locality, J. A. Elix 35789, 6 Sept. 1993 (CANB).

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TWO NEW AGARICS FOUND IN ANDALUCIA (PENINSULAR SPAIN)

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Summary. *Entoloma griseocyaneum* var. *glyciosmus* var. nov. and *Mycena gladiocystis* sp. nov. (sect. *Insignes*) are described and commented. Drawings of microcharacters are added.

Key words: *Entoloma griseocyaneum* var. *glyciosmus*, *Mycena gladiocystis*, Agaricales, taxonomy, Andalucía, Spain.

INTRODUCTION

These two new agarics are part of the research that both authors have been carrying out in the last years in two of the most interesting botanical areas of Andalucía, e.g. the *Abies pinsapo* Boiss. forests which extend in two localities of Cádiz and Málaga provinces (Grazalema and Ronda-Sierra de las Nieves), and the alpine grasslands of Sierra Nevada (Granada). Previous contributions to the mycoflora of these areas were published by ORTEGA & al. (1996, 1997).

Mycena gladiocystis was found growing on leaves of *Quercus ilex* subsp. *ballota* (Desf.) Samp. (= *Quercus rotundifolia* Lam.), in mixed areas of *A. pinsapo* with this evergreen oak. It is a new component of the very diverse foliicolous *Mycena* species that grow on *Q. ilex* leaves, e.g. *M. adscendens* (Lasch) Maas Geest., *M. mucor* (Batsch :Fr.) Gillet, *M. quercophila* Esteve-Rav. & Villarreal, *M. quercus-ilicis* Kühner or *M. smithiana* Kühner (see ESTEVE-RAVENTÓS & VILLARREAL, 1997), all of them rather frequent on this substrate when heavy and continuous rain favours their fructification.

On the other side, *Entoloma griseocyaneum* var. *glyciosmus* is a common agaric of the "borreguiles", a name which defines the alpine

grasslands of Sierra Nevada. A partial previous catalogue of the mycoflora of these areas (ORTEGA & al., 1997) did not include this taxon, which characteristic smell has been tested repeatedly in collections made in different years. A comparison with collections from (AH) of var. *griseocyaneum* (Fr. :Fr.) P. Kumm. which is commonly found in some alpine grasslands of the Spanish Pyrenees, has been made, both taxa revealing very similar macro and microcharacters.

MATERIAL AND METHODS

Both type collections have been deposited in (AH), University of Alcalá Herbarium, Spain. The microscopical study of the samples was made using NH_4OH (2 %) and Melzer's reagent. Line drawings of the figures were made with the aid of a camera lucida. Basidiospore measurements were obtained following the method proposed by HEINEMANN & RAMMELOO (1985). Authors' abbreviations follow KIRK & ANSELL (1992).

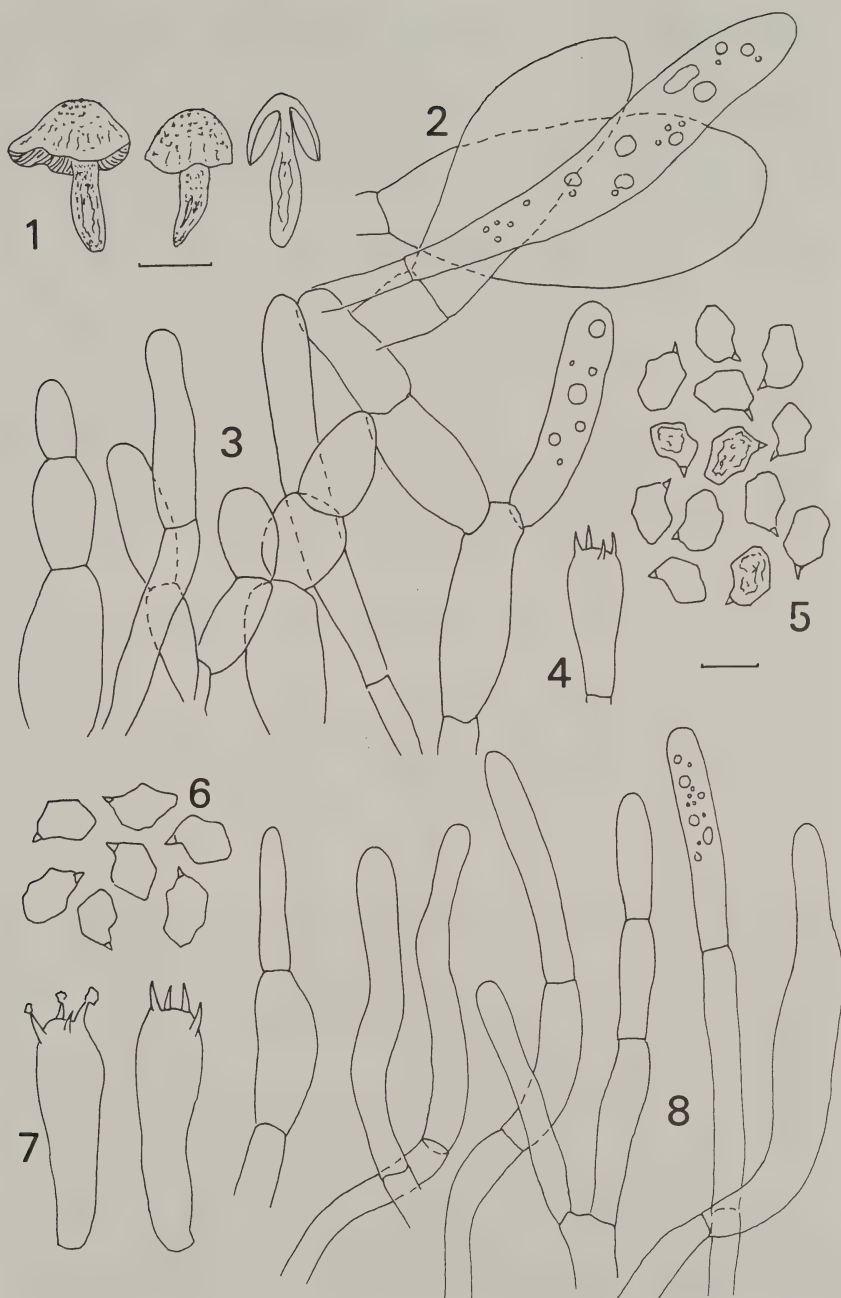
***Entoloma griseocyaneum* var. *glyciosmus* Esteve-Rav. & A. Ortega, var. nov.** (Figs. 1-5)

A typo differt odore glyciosmo simulanti. Habitat: inter graminis in pratis alpinis, 2.200-2.500 m, 17-VII-1997, Sierra Nevada (Granada), Andalucia, Hispania, AH 23426 (Holotypus).

Basidiomata gregarious (Fig. 1). Pileus 18-40 mm diam., hemisphaerical, convex to plano-convex, not umbonate or subumbonate, with deflexed to straight margin, not or slightly hygrophanous, not translucently striate, grey-brown, sepia or red-brown depending on the water content, the surface entirely subtomentose to fibrillose-squamulose, in old specimens even subsquarrose at the centre. Lamellae moderately distant, almost free to adnexed, ventricose, ascendant, at first white then pink, with concolorous and even edge. Stipe 20-40 x 4-8 mm, cylindrical, frequently compressed with longitudinal groove, base attenuate to slightly broadened, grey-blue, sky-blue to violaceous-blue, white at the base, the surface distinctly silvery fibrillose-furfuraceous and striate lengthwise. Context concolorous in cortex. Smell typically reminding of coconut, especially upon drying and in dried specimens (still recognizable in exsiccata). Taste mild.

Spores $L \times w = 9\text{-}10.3\text{-}11.5 \times 6.7\text{-}7.7\text{-}8.5 \mu\text{m}$, $Q = (1.2\text{-})1.25\text{-}1.35\text{-}1.47\text{-}(1.53)$ -

Figs. 1-5. *Entoloma griseocyaneum* var. *glyciosmus* (holotypus). 1.- Basidiomata. 2.- Terminal cells of the pileipellis. 3.- Terminal cells of the stiptipellis. 4.- Basidium. 5.- Spores. **Figs. 6-8.** *Entoloma griseocyaneum* var. *griseocyaneum* (AH 19450). 6.- Spores. 7.- Basidia. 8.- Terminal cells of the stiptipellis. Bar = 10 μm except basidiomata = 12 mm.



$n=21$ -, heterodiametrical, 5-8 angled in side view (Fig. 5). Basidia 28-40 x 9.5-12 μm , broadly clavate, 4-spored (but mono- and bisporic also present in a low number), clampless, sclerobasidia sometimes observed (Fig. 4). Cheilocystidia not seen. Pileipellis a subtrichoderm to a true trichoderm in places, the terminal elements usually inflated (x 10-40 μm broad), with brown intracellular content (Fig. 2). Subpellis with branched elements, usually constricted at the septa, 5.5-10 μm broad. Hymenophoral trama regular, made up of elements 90-130 x 5-20 μm . Caulocutis a trichoderm constituted by regularly septate hairs, constricted at the septa, often branched, 10-25 μm broad, with grey-bluish intracellular content (Fig. 3). Clamp-connections absent.

Habitat: in wet acid pastures (gneiss), among mosses and grasses in *Festuca iberica* communities (*Nardo strictae-Festucetum ibericae*).

Material studied. SPAIN. ANDALUCIA, GRANADA: Sierra Nevada, Borreguiles de San Juan, alt. 2.500 m, 5-IX-1996, L. Alcoba, F. Esteve-Raventós, A. Ortega & M. Villarreal, (AH 21652). Sierra Nevada, Campos de Otero, alt. 2.200 m, 17-VII-1997, L. Alcoba & A. Ortega, (AH23426 *Holotypus*). *Idem*, (AH 23427 *Paratypus*).

Other material studied.

Entoloma griseocyaneum var. *griseocyaneum* (Fr. :Fr.) P. Kumm. (Figs. 6-8)

SPAIN. ARAGON, HUESCA: San Nicolás de Bujaruelo, umbría del Gabieto, alt. 2.100 m, 30TYN3931, 15-VIII-1996, in calcareous alpine grasslands, *F. Arenal*, V. González & I. Pereira, (AH 19450). Parque Nacional de Ordesa, senda Punta Acuta-refugio de Calcilarruego, 1.950 m, 30TYN4125, 14-VIII-1997, in similar habitat, *F. Arenal*, *F. Esteve-Raventós* & V. González, (AH 23409).

The characteristic smell of coconut develops upon the drying process, but it is very distinctive, and also present in dried specimens. *E. griseocyaneum* has often been described lacking any particular smell (NOORDELOOS, 1987, 1992, 1994 -"not distinctive"-) or, if present, with a slightly farinaceous or "boletoid" smell when cut (JAMONI, 1996).

This new taxon is rather frequent in the acid wet pastures of the alpine range in Sierra Nevada, these locally called "borreguiles". The record extends the distribution range of *E. griseocyaneum* in Europe to more meridional areas. In our continent, *E. griseocyaneum* is locally widespread in montane and boreo-alpine areas of central and western Europe. With regard to pH preferences, it seems to be edaphically indifferent to acid or basic soils (NOORDELOOS, 1987, 1992); though more frequent in fertilized pastures, it can also be encountered in humid *Alnus* or *Corylus* forests.

According to our field experience, *E. griseocyaneum* is rather common in the subalpine and alpine calcareous pastures of the Spanish Pyrenees

(BALLARÀ, 1997; ESTEVE-RAVENTÓS & al., 1996). In the numerous samples studied by us from these areas, a distinctive smell was not present. The comparative study of collections from the Pyrenees and those of Sierra Nevada, has revealed that both agarics are very similar in both macro and microcharacters. The range of variation of colours, spore and basidial size, pileipellis structure and hymenophoral trama in both taxa are very similar. It has been observed, though, that the stipe covering in the Sierra Nevada agaric is constituted by mostly branched hairs, frequently constricted at the septa, whereas these are not or seldomly branched, longer and more cylindrical in those from the Pyrenees. But also in this case, some overlapping exists; consequently, this character seems to be of little taxonomical importance, and possibly influenced by environmental factors or age of the fruitbodies.

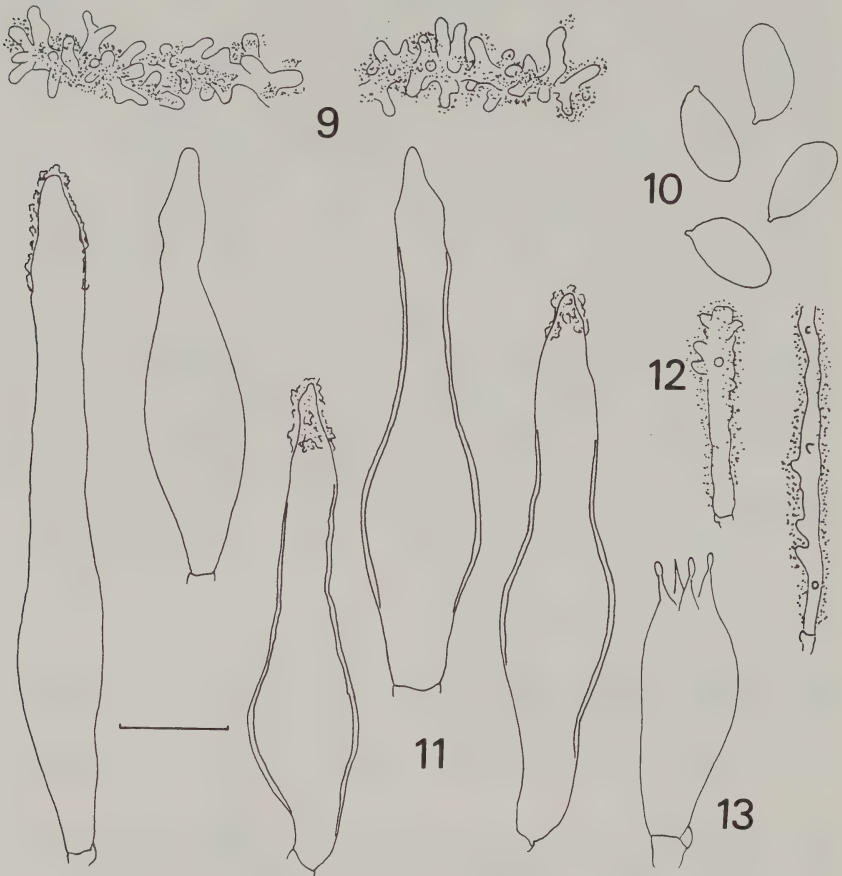
Another variety of *E. griseocyaneum* was published by FAVRE (1955) from the Swiss National Park as *Rhodophyllus griseocyaneus* var. *nudipes*. A lectotype was designed by HORAK (1993) from material collected by Favre in this National Park, the sample showing cheilocystidia and being devoid of the typical stipe covering; according to Horak, the var. *nudipes* should be considered a synonym of *E. poliopus* (Romagn.) Noordel. MAIRE (1933) described from Cataluña *E. griseocyaneum* var. *rhodocephalum*, which differs in the more red-brownish colours of the pileus; except for this character, the rest of Maire's description fits well with our concept of *E. griseocyaneum*, and this taxon is probably a color variant or form of this species.

***Mycena gladiocystis* Esteve-Rav. & A. Ortega sp. nov.** (Figs. 9-13)

Etymology: from latin "gladius" = sword, due to the shape of the cystidia

Basidiomata dispersa. Pileus usque ad 10 mm latus, convexus, haud umbonatus, leviter sulcatus et paulus translucide striatus, leviter lubricatus, luteo-olivaceus vel olivaceo-brunneus. Lamellae 15-20 stipitem attingentes, ascendentes, adnatae, dente decurrentes, usque 2 mm latae, flavido vel flavido-olivaceo tinctae, margine concolores. Stipes -50 x 1 mm, aequalis, fistulosus, pileo concolor, basi fibrillis albidis instructus. Caro tenuis, odore alcalino. Sporae 8-11 x 4-5.5 µm, laeves, amyloideae, ellipsoideae. Basidia 22-33 x 8-11 µm, clavata, 4-spora, fibulataque, sterigmatibus -5.5 µm longis praedita. Cheilocystidia 45-75 x 9-17 µm, lageniformia vel fusiformia, interdum crassotunicata (-0.5 µm), laeves. Pleurocystidia similia. Trama lamellarum dextrinoidea. Hyphae pileipellis -3 µm latae, fibulatae, surculis simplicibus vel subramosis munitae, in materiam gelatinosam immersae. Hyphae stipitis corticales fibulatae, in materiam gelatinosam immersae, laeves vel paulo diverticulatae, cellulae terminales laeves vel subramosae. Habitat: ad Quercus ilex subsp. ballota (Desf.) Samp. (= Q. rotundifolia

Lam.) folia decisa, 2-XI-1994, Nava de San Luis, Sierra de las Nieves, Ronda (Malaga), Andalucia, Hispania, AH 18819 (Holotypus).



Figs. 9-13. *Mycena gladiocystis* (holotypus). 9.- Diverticulate elements forming the suprapellis. 10.- Spores. 11.- Hymenial cystidia. 12.- Elements and terminal cell of the stipitipellis. 13.- Basidium. Bar = 12.5 μ m.

Basidiomata gregarious. Pileus 5-10 mm diam., convex to plano-convex, not umbonate, with straight margin, hygrophanous, translucent striate, yellow-olivaceous, then becoming brownish-olivaceous when drying, the surface smooth, slightly lubricous when wet but without separable gelatinous pellicle. Lamellae 15-20 reaching the stipe, ascending, not ventricose, adnate to subdecurrent by a tooth, yellowish to olivaceous, with concolorous or slightly paler edge. Stipe 20-50 x 1-1.5 mm, cylindrical, fistulose, concolorous with pileus, somewhat darker at the base, the surface smooth and lubricous, without gelatinous pellicle, the apex slightly pruinose, the

base more or less densely covered with long, rather fine to coarse whitish fibrils. Smell slightly nitrous.

Spores $L \times w = 8-9.5-11 \times (4-)4.2-4.9-5.6 \mu m$, $Q = (1.6-)1.65-1.95-2.2(-2.3)$ - $n=21$ -, smooth, hyaline, ellipsoid, amyloid (Fig. 10). Basidia $22-33 \times 8-11 \mu m$, clavate, 4-spored, clamped (Fig. 13). Cheilocystidia forming a sterile band, $45-75 \times 9-17 \mu m$, strongly projecting from the hymenium, narrowly fusiform to sublageniform, with long, acute, usually strangled neck, sometimes distinctly thick-walled ($-0.5 \mu m$ thick), often covered by resinous yellowish material at the apex, which is also present inside the cystidia (Fig. 11). Pleurocystidia abundant, similar to cheilocystidia, strongly projecting from the hymenium (Fig. 11). Pileipellis a cutis of clamped, cylindrical hyphae, the superficial elements $-3 \mu m$ broad, covered with cylindrical, simple or hardly ramified excrescences $-2 \mu m$ broad, embedded in gelatinous matter. (Fig. 9). Subpellis typically pseudoparenchymatous. Pigment brownish-yellowish, extracellular, parietal. Hymenophoral trama dextrinoid. Hyphae of the stipitipellis $3-5 \mu m$ broad, with scattered, simple and short excrescences, embedded in gelatinous matter, but without separable pellicle (Fig. 12). Clamp-connections present in all tissues.

Habitat: on fallen leaves of *Quercus ilex* subsp. *ballota* (Desf.) Samp. (= *Q. rotundifolia* Lam.).

Material studied. SPAIN. ANDALUCIA, MALAGA: Ronda, Sierra de las Nieves, Nava de San Luis, 2-XI-1994, *F. Esteve-Raventós & A. Ortega*, (AH 18819 *Holotypus*).

According to MAAS GEESTERANUS (1992), *M. gladiocystis* could be either classified in sect. *Insignes* Maas Geest. or in sect. *Carolinenses* Maas Geest. Taking into important account the presence of the particular thick-walled pleurocystidia (a character which is also present in *M. carolinensis* A.H. Sm. & Hesler), the new species might seem closer to this North American taxon; however, the distribution of the fibrils at the stipe base and the gelatinous, though not separable, pellicle in the pileipellis would better suggest its placement in sect. *Insignes* (MAAS GEESTERANUS, pers. comm.).

Either considered as a member of the one or the other section, *M. gladiocystis* shows a peculiar combination of characters which make it a very distinct species: yellow-olivaceous colours and the presence of both cheilo- and pleurocystidia, which are very typical by: 1) mostly possessing slightly thickened walls, 2) being smooth, 3) showing amorphous yellowish exsudates and 4) particular morphology which reminds that of a sword or a dagger. In *M. carolinensis*, a species which grows in North America on dead twigs and stems of *Rhododendron* and *Leucothoe* respectively, the cheilocystidia are more or less diverticulate; on the other hand, *M. insignis* A.H. Sm., which is only known from Washington (USA) growing on fallen Douglas fir and helmlock needles, shows very different macro and

microscopic characters from those of *M. gladiocystis* (MAAS GEESTERANUS, *loc. cit.*: 376-377).

Among the foliicolous species that grow on the diverse sclerophyllous species of *Quercus* in the Iberian Peninsula, only *M. quercophila* could be mistaken in the field, owing to the yellowish colors which are characteristic in both species; this is a member of sect. *Polyadelphia* Singer ex Maas Geest., with very different microscopic characters (ESTEVE-RAVENTÓS & VILLARREAL, *loc. cit.*).

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A NEW SPECIES AND A NEW RECORD FOR THE GENUS *XERULA*
(AGARICALES) FROM COSTA RICA

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ABSTRACT: *Xerula hispida* sp. nov. is described from *Quercus*-dominated forests of Costa Rica. It has been found in a number of sites throughout the country. The exact distribution outside of Costa Rica is unknown, but it is anticipated that it occurs in *Quercus*-dominated forests in other southern Central American countries. *Xerula steffenii* has also been collected in these forests, and a description of it is provided here. This is the first report of this latter taxon from Central America.

KEY WORDS: Agaricales, Costa Rica, macrofungi, new species, *Xerula*

A high diversity of Agaricales and other macrofungi are encountered in the montane *Quercus*-dominated forests of Costa Rica (Mueller & Halling 1995). We have encountered a number of previously undescribed species during field work undertaken to further document this diversity. In this paper we describe a new species of *Xerula* and present an updated description of *Xerula steffenii* (Rick) Boekhout & Bas.

Sampling was undertaken in *Quercus*-dominated forests throughout the Central Volcanic and the Talamanca Mountain ranges in central and southern Costa Rica at elevations from 1500-3300 meters elevation and in the Guanacaste Conservation Area in northwestern Costa Rica at elevations from 350-1400 meters elevation. The number of basidiospores measured plus the number of collections from which these basidiospores were sampled are provided in brackets to provide some indication of the reliability of these data (Bas 1974, Mueller 1992). $\bar{x}$ = mean range of basidiospore length x width. $\bar{Q}$ = mean basidiospore length/width ratio. Color designations in alphanumeric form (e.g., 6F4) are from Kernerup and Wanscher (1983).

Xerula hispida Halling & Mueller, sp. nov. Figs. 1-8.

Basidiomata diminutiva sicca hispida, basidiosporis magnis laevibus, dermat- et hymenocystidis setiformibus incrassatis et coloratis.

HOLOTYPE: Costa Rica. San Jose, San Gerardo de Dota, Albergue de Montaña, Savegre, ± 5 km SW of Cerro de la Muerte, $9^{\circ}33'2''N$, $83^{\circ}48'27''W$, 2500 m, 10 June 1994, G. M. Mueller 4696 (USJ), (ISOTYPE: F).

ETYMOLOGY: Named because of the hispid hairs covering the pileus and stipe.

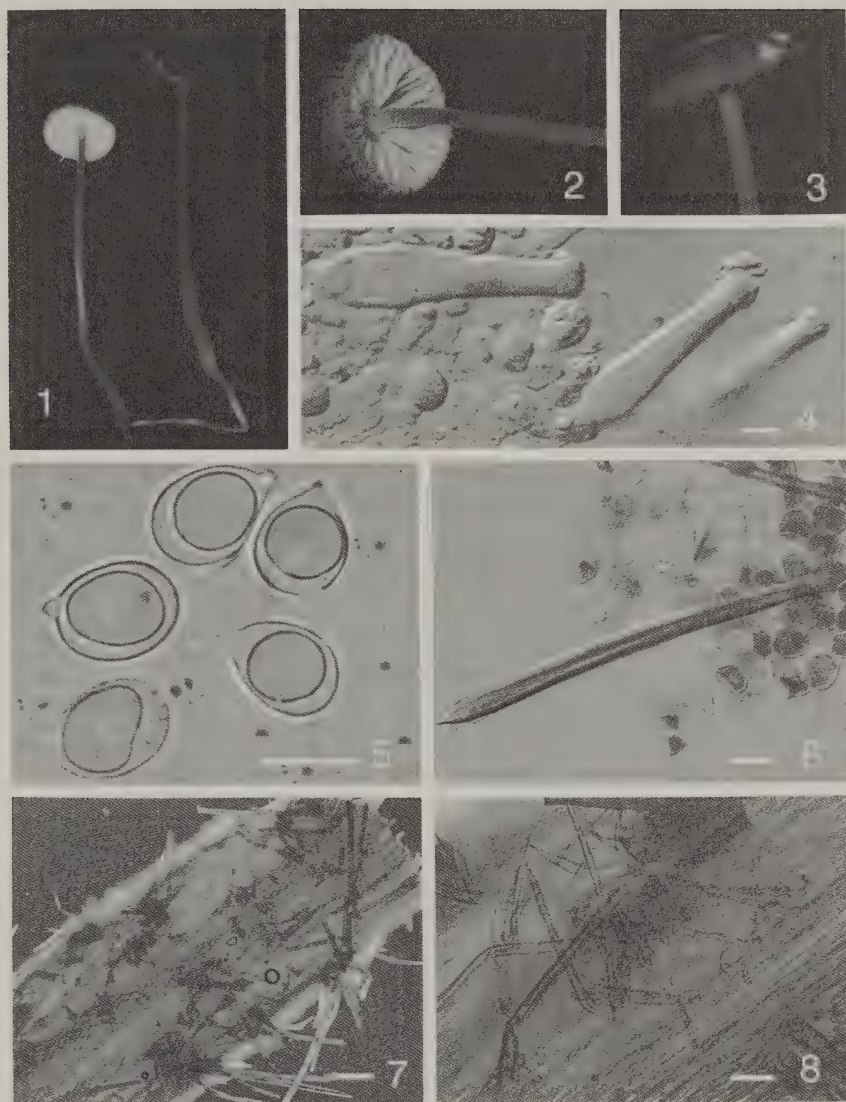
Pileus 5-20(-35) mm broad, conical, becoming campanulate to convex, often with a conical umbo, dry, finely rugulose overall, some subsulcate over margin, covered with

hispid orange-ochre erect hairs, hairs sparser over the disc, smooth under pubescence, dark brown at first (7E-F4-7), becoming slightly paler (6E-F4-5) to olivaceous (near 4D-E5); margin strongly inrolled, becoming incurved; context thin, white; odor and taste mild. **Lamellae** adnexed to adnate, close to subdistant, broad, $\pm$ waxy, white; margins hispid and concolorous. **Stipe** 50-150(-220) $\times$ 1-2(-7) mm, equal with a long tapered base which is mostly buried in the substrate, densely hispid with erect pubescent over entire exposed surface, orange-ochre brown (5D7 to 6C6-7) to subconcolorous with pileus (7D7-8), ground color pale creamy yellow at apex; interior hollow.

Basidiospores [280/6] (10.5-)11.5-15(-17.5) $\times$ (7.8-)10-13 μ m ($\bar{x}$ = 12-14.5 $\times$ 8.4-11.5 μ m), $\bar{Q}$ = 1.11-1.3(-1.5), smooth or very rarely finely verruculose, thin-walled, subglobose to subovoid, inamyloid, acyanophilous, uniguttulate. **Basidia** two-sterigmate, clavate, lacking siderophilous granules. **Pleurocystidia** (57-)85-154 $\times$ (10-)15-31(-50) μ m, abundant, ventricose, frequently with amorphous crystalline deposits on the apex (soluble in KOH and Melzer's), otherwise smooth, inamyloid, refractive, thick-walled, golden brown; walls up to 6 μ m; apex thin-walled, blunt to slightly rounded. **Cheilocystidia** similar to pleurocystidia, but generally smaller. **Lamellar trama** hyaline, inamyloid, sarcodimitic, interwoven to subparallel, with fusoid elements 70-200 $\times$ 10-20 μ m, interspersed with narrower elements that are 3-6 μ m broad, smooth and thin-walled. **Pileus trama** interwoven, hyaline, inamyloid, sarcodimitic, with elements similar to those of lamellar trama. **Pileipellis** hymeniform, not gelatinous, composed of clavate to sphaeropedunculate elements interspersed with conspicious setae; clavate to sphaeropedunculate elements 7-21 μ m broad, filled with brown, plasmatic pigment, smooth, generally thin-walled or sometimes thickened up to 1.2 μ m; setae (50-)175-600(-900) $\times$ 8-20 μ m, with refractive, golden brown walls up to 7 μ m thick and subacute to acute apices. **Stipitipellis** 4-6 μ m broad, composed of a layer of vertically oriented, refractive, thick-walled, golden brown hyphae, giving rise to fascicles of acute to subacute setae which are 200-520 $\times$ 8-15.5 μ m and individually similar to those in pileipellis, also giving rise to caulocystidia which are shorter and thinner walled than the setae. **Stipe trama** sarcodimitic, with hyphae compactly arranged, otherwise dimensionally similar to pileus and lamellar trama. **Clamp connections** absent.

MATERIAL EXAMINED: COSTA RICA. ALAJUELA, Grecia, Area de Conservacion Bosque del Niño, 10°9'4"N, 84°40'42"W, 1950 m, 6 August 1994, *J. L. Mata* 214 (USJ), 2 September 1994, *J. L. Mata* 237 (USJ), 23 September 1994, *J. L. Mata* 318 (USJ), 7 October 1994, *J. L. Mata* 352 (USJ), 29 June 1995, *J. L. Mata* 648-650 (USJ), 21 July 1995, *J. L. Mata* 715 (USJ), 3 August 1995, *J. L. Mata* 748 (USJ), 17 August 1995, *J. L. Mata* 788 (USJ), 18 May 1996, *G. M. Mueller* 5630 (USJ, F). PUNTARENAS, Coto Brus, Parque Internacional La Amistad, Las Alturas Biological Station, trail to Cerro Echandi, between markers 26 & 30, 8°57'N, 82°50'W, 1800-2000 m, 23 July 1991, *G. M. Mueller* 4250 (USJ, F), same locality but in first 500 meters of trail, 1700-1800 m, 2 August 1993, *E. M. Pine* 1039 (USJ, F), 3 August 1993, *G. M. Mueller* 4570 (USJ, F). SAN JOSE, El Jaular, Estación Biológica Cuerici, 9°33'17"N, 83°40'15"W, 2900 m, 24 August 1995, *A. E. Franco-M.* 1443 (USJ, NY); San Gerardo de Dota, Albergue de Montaña, Savegre, $\pm$ 5 km SW of Cerro de la Muerte, 9°33'2"N, 83°48'27"W, 2500 m, 8 August 1993, *G. M. Mueller* 4589 (USJ, F), 9 June 1994, *T. J. Baroni* 7482 (USJ, CORT), 10 June 1994, *R. E. Halling* 7270 (USJ, NY), 10 June 1994, *G. M. Mueller* 4696 (USJ, F), 21 June 1995, *G. M. Mueller* 5187 (USJ, F), 10 May 1996, *G. M. Mueller* 5421 (USJ, F), 12 May 1996, *G. M. Mueller* 5519 (USJ, F), 25 June 1995, *K. M. Shanks* 658 (USJ, NY); Villa Mills, Interamerican Highway, at kilometer 95, behind La Georgina Restaurant, 9°34' N, 83°45'W, 2900 m, 28 July 1991, *G. M. Mueller* 4281 (USJ, F).

Xerula hispida would fit in section *Xerula* (*Oudemansiella* subgenus *Xerula* sensu Pegler & Young 1987, *Xerula* sensu Redhead et al. 1987) by virtue of its non-gelatinizing, dry



Figs. 1-3. Basidiocarps of *Xerula hispida*: 1. G. M. Mueller 5360, 1/2x. 2. G. M. Mueller 5519, 1x. 3. G. M. Mueller 5421, 1x.

Figs. 4-8. Micromorphological features of *Xerula hispida*, G. M. Mueller 4696: 4. Pleurocystidia, scale bar = 10 μ m. 5. Basidiospores, scale bar = 10 μ m. 6. Scalp section of pileipellis showing thick-walled conspicuous seta, scale bar = 50 μ m. 7. Low magnification of scalp section of stiptipellis showing fascicles of acute to subacute setae, scale bar = 100 μ m. 8. Same as Fig. 7 but at higher magnification, scale bar = 50 μ m.

pileus that bears setiform pileocystidia. Setiform cystidia are also present in the hymenium and on the stipe of *X. hispida*. The spore size for our taxon is larger ($>10\ \mu\text{m}$) than that allowed by Pegler and Young (1987) for the section. The only other species reported from the neotropics are *X. steffenii* (Rick) Boekhout & Bas (see below), *X. macracantha* (Singer) Boekhout & Bas, *X. radicata* (Rehlan) Dörfelt, and *X. pilosa* (Rick) Singer. The first two can be easily distinguished by their bluntly echinate spores and gelatinizing pileipellis. *Xerula radicata* lacks pileocystidia and caulocystidia, and *X. pilosa* is thought to be a *Crinipellis* (Pegler & Young 1987). In section *Xerula*, *X. pudens* (Pers.) Singer, *X. americana* Dörfelt, and *X. melanotricha* Dörfelt have been recognized (cfr. Dörfelt 1981, Pegler & Young 1987, Redhead et al. 1987). Both *X. pudens* and *X. melanotricha* appear to be confined to Europe where they are associated with *Fagus*. Also, the basidiomata are significantly larger and produce smaller spores than *X. hispida*. *Xerula americana* seems restricted to the Rocky Mountains of North America (Dörfelt 1981, Mitchel & Smith 1978, but see Redhead et al. 1987) where the fungus is found on dead aspen (*Populus tremuloides* Michx.). The setiform pileocystidia of *X. americana* are hyaline and the hymenial cystidia are not setiform. Petersen and Methven (1994) reported non-clamped, bisporic basidiomes of the European *Xerula radicata* complex which they concluded were non-meiotic, haploid monokaryotic, and essentially asexual. We have no data on mating systems of *X. hispida*.

Ying and Zang (1994) report *X. pudens*, as *Oudemansiella pudens* (Pers.) Pegler & Young, from southwest China. The pileus size and basidiospore dimensions given (pileus 3-6 mm diam and basidiospores $10\text{-}15 \times 8\text{-}13.8\ \mu\text{m}$) are more similar to *X. hispida* than to *X. pudens*. This may be another example of a Western Hemisphere/temperate east Asian disjunct (see Wu & Mueller 1997 for other examples).

Xerula steffenii (Rick) Boekhout & Bas, Persoonia 13: 55. 1986.

Tricholoma steffenii Rick, Broteria 24: 99. 1930.

Oudemansiella steffenii (Rick) Singer, Lilloa 26: 66. 1953.

Oudemansiella echinosperma Singer, Mycologia 37: 439. 1945.

Pileus 3.5-8 cm diam, plane, with uplifted margin; surface wet, hygrophanous, finely velutinous, rugulose toward the center, even or rugulose at the disc, brown (5-6-7E-F7-6-5); margin sulcate ($\pm 1.5\ \text{cm}$ from margin to center or halfway to disc); context (1.5-)-3-5 mm thick, stuffed, white and unchanging; odor and taste mild. **Lamellae** free to barely attached to adnexed, or sometimes adnate with a decurrent tooth, subdistant to distant, 6 mm broad, white to gray (6D3); margin broadly undulate, otherwise even, concolorous with faces or sometimes marginate and dark brown. **Stipe** (90-)-120-200 $\times$ (3-)-5-6 mm, slightly broader below, then abruptly tapering and radicating, central, white with gray to brown furfuraceous ornamentation; context white, unchanging, becoming hollow.

Basidiospores (excluding ornamentation) [20/1] $10.5\text{-}14 \times 10.5\text{-}13.3\ \mu\text{m}$ ($\bar{x} = 11.9 \times 11.8\ \mu\text{m}$), $Q = 1.01$, globose to rarely slightly subglobose, hyaline to slightly refractive in KOH, inamyloid, obtusely echinate; spines $1.5\text{-}3.5\ \mu\text{m}$ long, up to $2.4\ \mu\text{m}$ broad at base. **Basidia** $40\text{-}55 \times 12\text{-}18\ \mu\text{m}$, densely guttulate, clavate, four-sterigmate.

Pleurocystidia $70\text{-}140 \times 10\text{-}40\ \mu\text{m}$, conspicuous, hyaline, thin-walled to slightly thick-walled, broadly ventricose and typically broadly mucronate-capitate, narrowly pedicellate, frequently with a pale brown resinous pigment on the apex. **Cheilocystidia** of two types: (1) filamentous and intertwined, usually with scattered pale brown intracellular pigment, (2) $20\text{-}95 \times 14\text{-}24\ \mu\text{m}$, vesiculose-saccate, very rarely fusoid, thin-walled, the larger ones usually collapsed, hyaline or rarely with intracellular pale brown pigment.

Lamellar trama sarcodimitic, with descending fusoid cells up to $80 \times 15\ \mu\text{m}$, intertwined by filamentous hyphae $3\text{-}5\ \mu\text{m}$ broad, diverging and gelatinizing near the lamellar edge. **Pileus trama** sarcodimitic, similar to lamellar trama. **Pileipellis**

hymeniform, often gelatinous, composed of clavate to sphaeropedunculate elements 12-35 μm broad, hyaline or filled with brown, plasmatic pigment, smooth, generally thin-walled, arising from a radially arranged subpellis composed of filamentous hyphae that are 3-5 μm broad and contain brown plasmatic pigment. **Stipitipellis** composed of a layer of vertically oriented hyphae 1.5-3.5 μm broad, giving rise to fascicles of caulocystidia; caulocystidia 50-110 μm long, obclavate to subcylindric, hyaline or with brown plasmatic pigment. **Stipe trama** sarcodimitic, hyaline, inamyloid; hyphae compactly arranged, otherwise dimensionally similar to pileus and lamellar trama. **Clamp connections** present in all tissues.

MATERIAL EXAMINED: COSTA RICA. GUANACASTE, Parque Nacional Guanacaste, Cerro Cacao, near Estación Biológica Cacao, 10°55'42"N, 85°27'50"W, 1400 m, 4 June 1994, *R. E. Halling* 7232 (USJ, NY), 27 November 1994, *A. E. Franco-M.* 1323 (USJ, NY); Sector Pailas, Rincon de la Vieja, trail to volcano, 25 June 1997, *D. Quist* 21 (INBio, F). PUNTARENAS, Valle de Coto Brus, near San Vito, OTS Wilson Botanical Garden, River Trail, 8°47'9"N, 82°57'31"W, 1100 m, 6 November 1989, *R. E. Halling* 6328 (NY).

EXTRALIMITAL MATERIAL EXAMINED: BOLIVIA. BENI, José Ballivián, S of Rurrenbaque, along Río Beni, between Rurrenbaque and junction of Río Tuichi, $\pm 14^{\circ}25'S$, $67^{\circ}30'W$, 31 March 1990, *R. E. Halling* 6380 (LPB, NY). FRENCH GUIANA. SAÛL, Limonade Trail, $3^{\circ}37'N$, $53^{\circ}12'W$, ± 250 m, *S. A. Mori* 18276 (NY). PANAMA. SAN BLAS, between Puerto Obaldia and Darien, 22 June 1975, *K. P. Dumont-PA* 1058 (NY). VENEZUELA. AMAZONAS, near Cerro de la Neblina, along Río Mawarinuma, $\pm 0^{\circ}50'N$, $66^{\circ}10'W$, ± 140 m, 23 February 1985, *R. E. Halling* 4291 (VEN, NY). ARAGUA, Parque Nacional "Henry Pittier," Estación Biológica Rancho Grande, $\pm 10^{\circ}21'N$, $67^{\circ}41'W$, 12 July 1987, *R. E. Halling* 5360 (VIA, NY).

Xerula steffenii is easily characterized because it is one of two species with obtusely echinate basidiospores. *Xerula macracantha* also has this type of ornamented spore, but the ornamentations are longer and the spores are larger. Also, *X. macracantha* appears restricted to the Amazonas region of South America (Singer 1964).

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NEW SPECIES AND NEW RECORDS IN THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTINA) FROM THAILAND

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ABSTRACT : The following new lichen species are described from Thailand, *Everniastrum scabridum* Elix & Pooprang, *Hypotrachyna chlorobarbatica* Elix & Pooprang, *Hypotrachyna ramkhamhaengiana* Elix & Pooprang, *Parmotrema rubromarginatum* Elix & Pooprang and *Parmotrema thailandicum* Elix & Pooprang. In addition, the new combination *Parmelinella chozoubae* (Singh & Sinha) Elix & Pooprang is made and 29 species of Parmeliaceae are reported for the first time for Thailand.

Introduction

In recent years there has been a significant increase in interest and appreciation of the lichen flora of Thailand, with intensive localised studies of lichen biodiversity (Boonpragob *et al.* 1998; Mongkonsuk *et al.* 1996), as well as detailed floristic and ecological investigations (Wolseley 1997, Wolseley & Aguirre-Hudson 1991, 1997a,b; Wolseley *et al.* 1994). We have recently undertaken a detailed survey of the lichen family Parmeliaceae in Thailand culminating in our describing five species new to science and 29 new records for the country. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson *et al.* 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993; Elix *et al.* 1988), high performance liquid chromatography (Feige *et al.* 1993) and comparison with authentic samples.

Everniastrum scabridum Elix & Pooprang, sp. nov.

Fig. 1

Species cum thallo ut in *Everniastrum arsenei* sed ab hac specie lobis eciliatis, subto sparsim rhizinoso, sporis majoribus et acido gyrophorico noncontinente differt.

Type: Thailand. Chiang Mai Province: Queen Sirikit Botanic Gardens, 18°48'N, 98°58'E, ca. 1000 m, on *Pinus kesiya* in deciduous forest, T. Pooprang 3306.1, 8 Nov. 1994; holo: RAMK.

Thallus foliose, corticolous, loosely adnate, to 4-5 cm wide. Lobes separate, linear-elongate to subirregular, dichotomously to subdichotomously branched, $\pm$ involute, 1.0-2.0 mm wide, eciliate. Upper surface pale grey or darkening with age, $\pm$ flat to weakly to markedly convex, shiny and smooth at the margins, dull and rugose within, distinctly maculate, lacking pustules, soredia and isidia. Medulla white. Lower surface ivory to pale tan in a broad marginal zone, otherwise dull, black, rugulose; rhizines very sparse, if present mainly laminal, sparingly branched, black. Apothecia stipitate, eperforate, 2-7 mm wide; disc concave to $\pm$ undulate-distorted, dark brown to olive-brown; thalline exciple maculate, markedly rugose and ridged, margin narrow, becoming undulate. Ascospores ellipsoidal to reniform, 20-25 $\times$ 8-10 μ m. Pycnidia common, laminal. Conidia bacilliform to weakly bifusiform, 5-7 $\times$ 1 μ m.

Chemistry: Cortex K+ yellow; medulla K-, C-, P+ orange-red; containing atranorin (minor), chloroatranorin (minor), protocetraric acid (major), protolichesterinic acid (major), lichesterinic acid (minor/trace), virensic acid (minor), conprotocetraric acid (trace).

The chemistry and morphology of this new species is similar to that of *Everniastrum arsenei* (Hale & M. Wirth) Hale ex Sipman, a Neotropical species with smaller spores (18-21 $\times$ 8 μ m), more markedly involute, regular lobes, an emaculate or obscurely maculate upper surface, conspicuous marginal cilia, and which often contains accessory gyrophoric acid in the medulla. *Everniastrum scabridum* can be readily distinguished by its eciliate margins, the very sparsely rhizinate, rugulose, lower surface with a broad, pale marginal zone (from 5-10 mm wide) and the larger spores. At present this new species is known from several localities in Chiang Mai Province, northern Thailand.

Specimens Examined

THAILAND. Chiang Mai Province: Doi Suthep-Pui, 30°41'S, 30°16'E, 1400 m, on *Diospyros* sp. in plantation, T. Pooprang 241/5, 5 March 1998 (RAMK); type locality, on *Pinus kesiya* in deciduous forest, T. Pooprang 3433, 8 Nov. 1994 (RAMK).

Hypotrachyna chlorobarbatica Elix & Pooprang, sp. nov.

Fig. 2

Species cum thallo ut in *Hypotrachyna physcioides* sed ab hac specie elobulato, superfice superior emaculato et acido 5-chloro-4-O-demethylbarbatico et methylo 5-chloro-4-O-demethylbarbatato continente differt.

Type: Thailand. Nakhon Ratchasima Province: Khao Yai National Park, 30°41'S, 30°16'E, ca. 1400 m, on bark in evergreen forest, *T. Pooprang* 9708, 4 Nov. 1997; holo: RAMK; iso: CANB.

Thallus foliose, corticolous, adnate, to 2-4 cm wide. *Lobes* not imbricate, separate or crowded, sublinear-elongate, subdichotomously to irregularly branched, 1.0-2.0 mm wide, eciliate. *Upper surface* pale grey to grey, flat, shiny and smooth, becoming dull and rugulose, emaculate, lacking pustules, soredia and isidia. *Medulla* white. *Lower surface* dull, black; rhizines moderately dense to dense, dichotomously branched, black. *Apothecia* substipitate, 4-10 mm wide; disc concave to $\pm$ flat, brown; thalline exciple smooth, margin narrow, undulate. *Ascospores* ellipsoid, 8-11 $\times$ 5-7 μ m. *Pycnidia* not seen.

Chemistry: Cortex K+ yellow; medulla K-, C+ orange, KC+ orange, P-; containing atranorin (minor), chloroatranorin (minor), methyl 5-chloro-4-O-demethylbarbatate (major), barbatic acid (minor), 5-chloro-4-O-demethylbarbatic acid (minor), 4-O-demethylbarbatic acid (major), unknowns (trace).

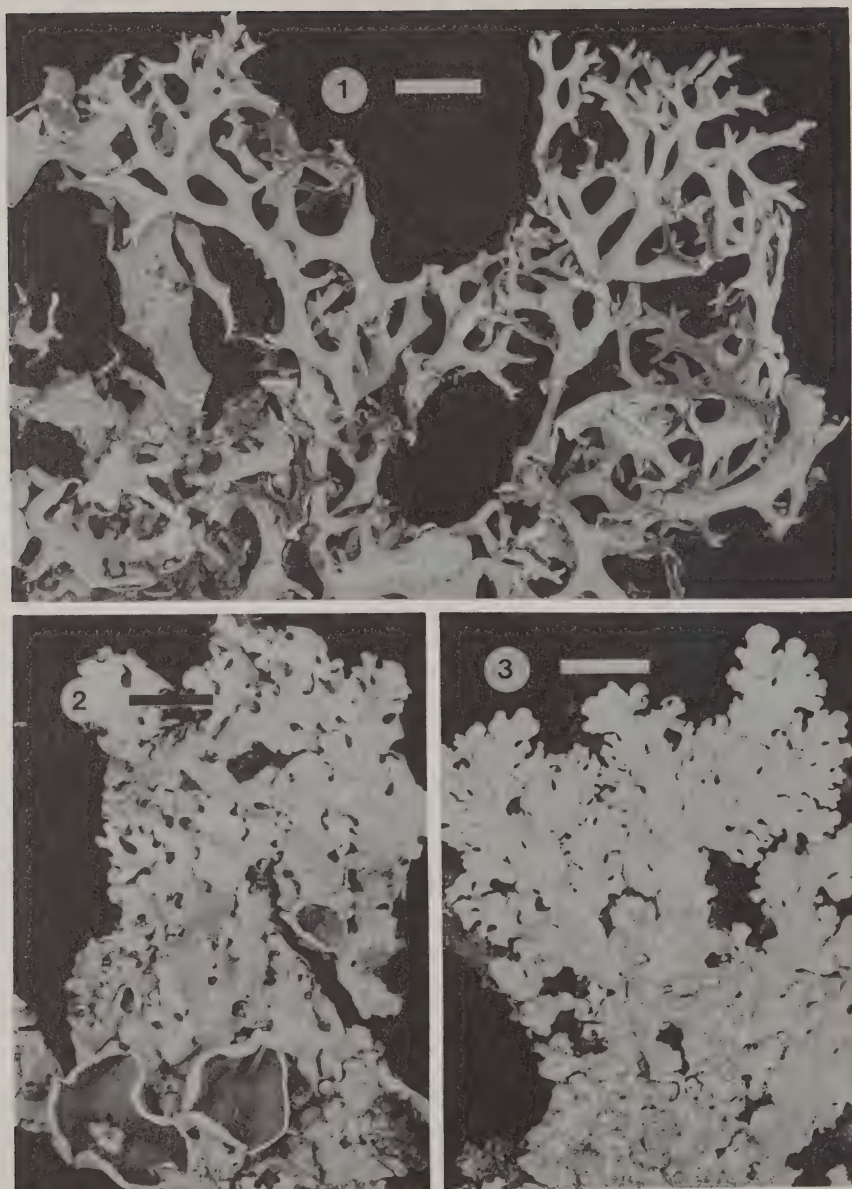
In overall morphology the new species resembles *Hypotrachyna physcioides* (Nyl.) Hale, and both are characterized by adnate thalli, narrow, sublinear-elongate lobes with a black lower surface and the presence of medullary barbatic and 4-O-demethylbarbatic acids. However, *H. physcioides* is clearly distinguished by the maculate upper surface of the lobes and the common lobulate-laciniae, whereas *H. chlorobarbatica* lacks these morphological features and contains additional methyl 5-chloro-4-O-demethylbarbatate and 5-chloro-4-O-demethylbarbatic acid. At present this new species is only known from the type collection.

Hypotrachyna ramkhamhaengiana Elix & Pooprang, sp. nov.

Fig. 3

Species cum thallo ut in *Hypotrachyna crenata* sed ab hac specie medulla flavescens, isidiis simplicibus et acido salazinico et acido consalazinico continente differt.

Type: Thailand. Sakon Nakhon Province: Phu Pan National Park, 30°41'S, 30°16'E, 120-200 m, on *Dillenia* sp. in mixed deciduous forest, *T. Pooprang* 8928, 7 Oct. 1997; holo: RAMK.



Figures 1-3. New species of Parmeliaceae: 1, *Everniastrum scabridum* (holotype in RAMK); 2, *Hypotrachyna chlorobarbatica* (holotype in RAMK); 3, *H. ramkhamhaengiana* (holotype in RAMK). Scale bar = 5 mm.

Thallus foliose, corticolous, adnate, to 4-6 cm wide. *Lobes* not imbricate, crowded, sublinear, subdichotomously to irregularly branched, 1.5-5.0 mm wide, eciliate. *Upper surface* pale grey to grey, flat, shiny and smooth, becoming strongly white-maculate, lacking pustules and soredia, isidiate; isidia moderate to dense, cylindrical, simple or rarely branched, slender, not darkening at the apices. Medulla white or yellow in part. *Lower surface* dull, black; rhizines moderately dense to dense, simple or sparsely dichotomously branched, black. *Apothecia* and *pycnidia* not seen.

Chemistry: Cortex K+ yellow; medulla K+ yellow then dark red, C-, P+ orange-red; containing atranorin (minor), chloroatranorin (minor), salazinic acid (major), pigmentosin A (minor), consalazinic acid (trace), secalonic acid A (trace).

This species is characterized by the simple, cylindrical isidia, yellow medulla, the sparsely branched rhizines and the presence of salazinic acid. In overall morphology it resembles *Hypotrachyna crenata* (Kurok.) Hale, since both have adnate thalli, sublinear lobes and cylindrical isidia. However, *H. crenata* is clearly distinguished by the white medulla, the coralloid branched isidia and the presence of stictic, constictic and norstictic acids in the medulla. *Hypotrachyna ramkhamhaengiana* contains the medullary pigment pigmentosin A, a quinone of unknown structure and one of the so-called schenckiana unknowns present in *Xanthoparmelia schenckiana* (Müll. Arg.) Hale (Elix *in sched.*). At present this new species is only known from the type collection. *Hypotrachyna ramkhamhaengiana* may well represent the isidiate counterpart of *H. coorgiana* Patw. & Prabhu, a fertile, primary species also known from the region. The specific epithet honours King Ramkhamhaeng who introduced the Thai alphabet in 1283 and after whom Ramkhamhaeng University is named. At present this new species is known only from the type locality.

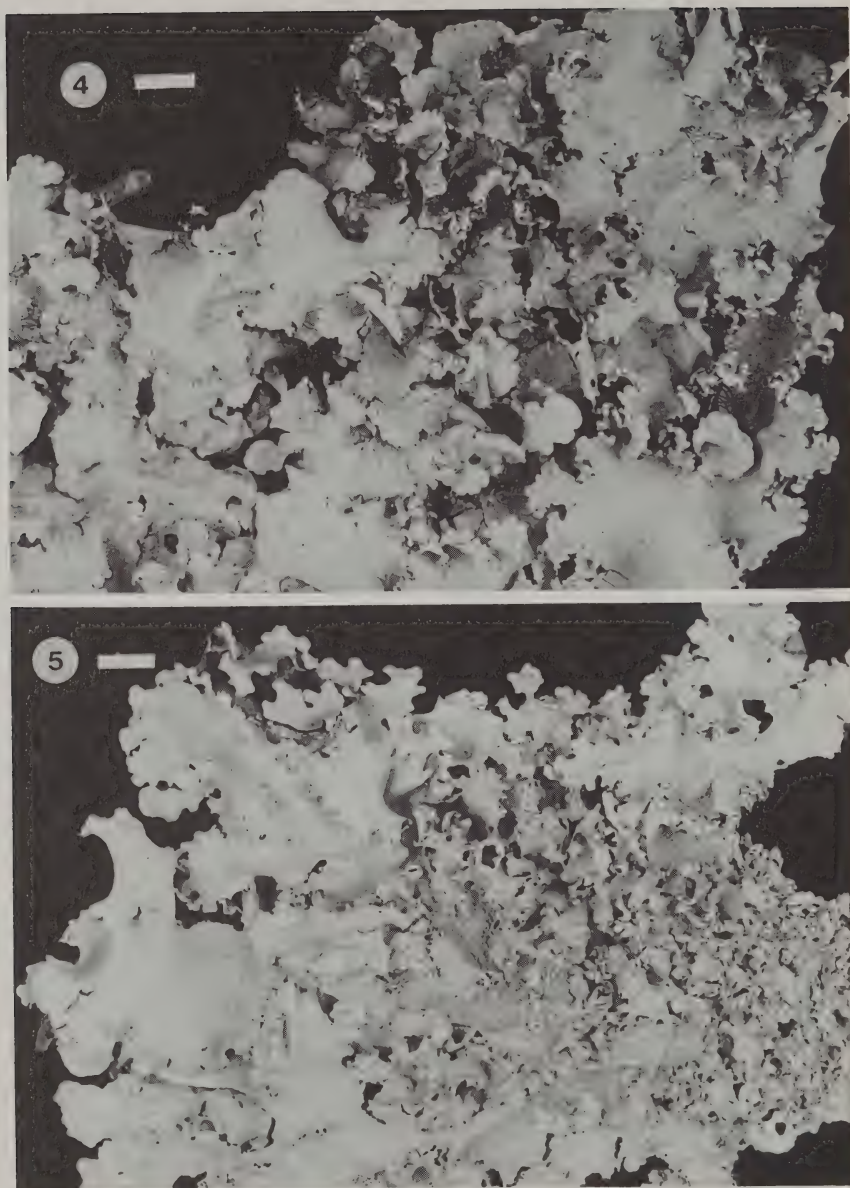
***Parmotrema rubromarginatum* Elix & Pooprang, sp. nov.**

Fig. 4

Species cum thallo ut in *Parmotrema subarnoldii* sed ab hac specie facie inferiore ad apicibus pigmento rubro et pigmento incognito continente differt.

Type: Thailand. Nakhon Ratchasima Province: Khao Yai National Park, 30°41'S, 30°16'E, 600 m, on *Syzygium* in plantation, T. Pooprang 8079, 19 Aug. 1997; holo: RAMK; iso: CANB.

Thallus corticolous, foliose, loosely adnate, membranaceous, to 8-12 cm wide. *Lobes* rounded or irregularly incised, 8-12 mm wide; margins entire or crenate, often ascending; cilia conspicuous, slender, 3-6 mm long, containing red pigment. *Upper surface* pale grey to grey-green, shiny,



Figures 4-5. New species of *Parmotrema*: 4, *P. rubromarginatum* (holotype in RAMK); 5, *P. thailandicum* (holotype in RAMK). Scale bar = 5 mm.

emaculate or faintly maculate, often uneven and wrinkled, isidia lacking; soralia marginal, linear on broad lobes or terminal on narrow, lateral lobes; soredia farinose. *Medulla* white. *Lower surface* black, with a broad, brown and in part red-pigmented, erhizinate marginal zone; sparsely rhizinate, the rhizines black, scattered, simple. *Apothecia* not seen. *Pycnidia* scattered, submarginal, immersed. *Conidia* sublageniform, $7-8 \times 1 \mu\text{m}$.

Chemistry. Cortex K⁺ yellow; medulla K⁻, C⁻, KC⁺ yellow then brown, P⁺ orange-red; containing atranorin (major), chloroatranorin (minor), protocetraric acid (major), protolichesterinic acid (minor), unknown pigment (minor).

Morphologically *P. rubromarginatum* closely resembles *P. subarnoldii* (des Abbayes) Hale, as these two species have similar loosely adnate, membranaceous thalli with cilia, marginal soralia and contain protocetraric acid in the medulla. However, *P. rubromarginatum* can clearly be separated by the red pigmentation of the lower surface near and at the margins of the lobes and by the similar pigmentation of the cilia. This pigmentation is due to substantial concentrations of an unknown quinonoid pigment which reacts K⁺ purple. At present, the new species is known from several localities in north-east Thailand.

Additional Specimen Examined

THAILAND. Loei Province: Nahaew, 17°05'N, 101°05'E, ca. 600 m, on *Shorea obtusa* in dry dipterocarp forest, T. Pooprang 7063, 8 Nov. 1995 (RAMK).

***Parmotrema thailandicum* Elix & Pooprang, sp. nov.**

Fig. 6

Species cum thallo ut in *Parmotrema amaniense* sed ab hac specie lobis eciliatis et lobulatis, medulla inferiore $\pm$ pigmento ochraceo et sporis brevioribus differt.

Type: Thailand. Phitsanulok Province: Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, ca. 1100 m, on bark in evergreen forest, T. Pooprang 18/22, 22 Feb. 1998; holo: RAMK; iso: CANB.

Thallus corticolous, foliose, loosely adnate, coriaceous, to 8 cm wide. *Lobes* rounded or apices irregularly incised, 5-10 mm wide; margins entire or crenate, often ascending; cilia absent. *Upper surface* pale grey to grey-green, shiny, emaculate or faintly maculate, often uneven and wrinkled, soredia and isidia lacking; becoming lobulate-laciniate towards the centre. *Medulla* white for the most part, $\pm$ yellow-orange pigmented adjacent to lower cortex. *Lower surface* black, with a broad, brown erhizinate marginal zone; sparsely rhizinate, the rhizines black, scattered, simple. *Apothecia* subpedicellate, 2-3

mm wide; disc concave, dark brown; exciple dentate. Ascospores obovate, 22-25 x 10-12 μm . *Pycnidia* very common, submarginal, immersed. *Conidia* sublageniform, 7-8 x 1 μm .

Chemistry. Cortex K+ yellow; medulla K+ pale yellow-brown, C-, P+ red; containing atranorin (minor), chloroatranorin (minor), alecoronic acid (minor), protocetraric acid (major), virensic acid (trace), subvirensic acid (trace), conprotocetraric acid (trace), skyrin (trace).

This new species resembles *Parmotrema amaniense* (Stein. & Zahlbr.) Krog & Swinscow in both morphology and medullary chemistry, as both species have loosely adnate, coriaceous thalli and contain protocetraric and alecoronic acids in the medulla. However, *P. thailandicum* differs in lacking cilia (*P. amaniense* has prominent cilia 3-7 mm long), in developing lobulate laciniae towards the centre of the thallus (*P. amaniense* is elobulate), in the intermittent yellow-orange pigmented lower medulla due to the presence of skyrin (in *P. amaniense* the medulla lacks pigments) and in the smaller spores (22-25 x 10-12 cf. 25-40 x 15-18 μm). At present this species is only known from the type collection.

New Records for Thailand

Bulbothrix hypochraea (Vain.) Hale, *Phytologia* 28: 480 (1974)

This species was known previously from Africa and South America (Hale 1976).

Specimen Examined

THAILAND. Chiang Mai Province: Queen Sirikit Botanic Garden, 18°48'N, 98°58'E, 700 m, on bark of *Protium serratum* in dry dipterocarp forest, T. Pooprang 3474, 9 Nov. 1994 (RAMK).

Bulbothrix meizospora (Nyl.) Hale, *Phytologia* 28: 480 (1974)

This species was known previously from Africa, Pakistan, India and Nepal (Hale 1976).

Specimens Examined

THAILAND. Chiang Mai Province: Queen Sirikit Botanic Garden, 18°48'N, 98°58'E, 700 m, on bark of *Dipterocarpus tuberculatus* in dry dipterocarp forest, K. Boonpragob et al. 2901, 3 Nov. 1994 (RAMK). Loei Province: Phu Rhoa National Park, 17°05'N, 101°20'E, 1200 m, on bark in *Pinus* forest, T. Pooprang 7863, 7 April 1996 (RAMK).

Bulbothrix queenslandica (Elix & Stevens) Elix, *Mycotaxon* 47: 126 (1993)

This species was known previously from Australia (Elix 1994a).

Specimens Examined

THAILAND. Chiang Mai Province: Queen Sirikit Botanic Garden, 18°48'N, 98°58'E, 700 m, on bark of *Dipterocarpus tuberculatus* in dry dipterocarp forest, K. Boonpragob et al. 289, 25 Jan. 1994 (RAMK). Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 900 m, on bark in evergreen forest, T. Pooprang 6982, 8 Dec. 1995 (RAMK). Phitsanulok Province: Pachuthong, Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1475 m, on bark in mixed deciduous forest, T. Pooprang 15/22, 22 Feb. 1998 (RAMK).

Bulbothrix sensibilis (Stein. & Zahlbr.) Hale, *Phytologia* 28: 481 (1974)

Previously known from Africa and South America (Hale 1976).

Specimen Examined

THAILAND. Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 700 m, on bark in evergreen forest, T. Pooprang 7790, 5 April 1996 (RAMK).

Canomaculina subtinctoria (Zahlbr.) Elix, *Mycotaxon* 65: 477 (1997)

This widespread species also occurs in Australia, North and South America, Africa, Asia (China, India, Japan, Nepal), Indonesia and New Zealand (Elix 1994d, Kurokawa 1991).

Specimen Examined

THAILAND. Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 900 m, on bark of *Dipterocarpus* sp. in evergreen forest, T. Pooprang 4651, 12 Feb. 1995 (RAMK).

Hypotrachyna adducta (Nyl.) Hale, *Phytologia* 28: 341 (1974)

This Asian species is also known from Nepal, India, Malaysia, the Philippines, Taiwan, Japan and New Guinea (Awasthi 1977a, Kurokawa 1979, Singh & Sinha 1994).

Specimens Examined

THAILAND. Chiang Mai Province: Doi Inthanon National Park, 18°32'N, 99°29'E, 2000 m, on bark in evergreen forest, T. Pooprang 177/4, 178/4, 179/4, 4 Mar. 1998 (RAMK).

Hypotrachyna adjuncta (Hale) Hale, *Phytologia* 28: 341 (1974)

This Asian species is also known from India, Malaysia, Philippines, Taiwan and Japan (Hale 1972).

Specimens Examined

THAILAND. Phitsanulok Province: Pachuthong, Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1475 m, on bark of *Syzygium* sp. in evergreen forest, R. Noicharoen 9441.1, 21 Oct. 1997 (RAMK); same locality, on bark in mixed deciduous, T. Pooprang 66/24, 24 Feb. 1998 (RAMK); same locality, on rock, T. Pooprang 107/24, 24 Feb. 1998 (RAMK).

Hypotrachyna coorgiana Patw. & Prabhu, *Bryologist* 80: 348 (1997)

This species was previously known only from India (Awasthi 1988, Patwardhan & Prabhu 1977). It contains the medullary pigment pigmentosin B, a quinone of unknown structure which is also the major pigment present in *Myelochroa denegans* (Nyl.) Elix & Hale (Elix *in sched.*).

Specimens Examined

THAILAND. Nakhon Ratchasima Province: Khao-Khiew, Khao Yai National Park, 14°11'S, 101°11'E, ca. 1400 m, on bark in evergreen forest, T. Pooprang 9710, 4 Nov. 1997 (RAMK). Phitsanulok Province: Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1200 m, on rock in evergreen forest, T. Pooprang 29/23, 23 Feb. 1998 (RAMK).

Hypotrachyna immaculata (Kurok.) Hale, *Smithsonian Contr. Bot.* 25: 41 (1975)

A temperate and tropical species also known from Australia, Africa and South America.

Specimen Examined

THAILAND. Phitsanulok Province: Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1100 m, on bark in evergreen forest, T. Pooprang 16/22, 22 Feb. 1998 (RAMK).

Hypotrachyna physcioides (Nyl.) Hale, *Smithsonian Contr. Bot.* 25: 54 (1975)

A common species in tropical America, India, Malaysia and Papua New Guinea (Hale 1975).

Specimens Examined

THAILAND. Chiang Mai Province: Doi Suthep-Pui, 18°49'N, 99°53'E, 1600 m, on bark in evergreen forest, K. Boonpragob *et al.* 3123, 7 Nov. 1994, 4025, 16 Jan. 1995 (RAMK). Loei Province: Nahaew National Park, 17°05'N,

101°05'E, 900 m, on bark in evergreen forest, *T. Pooprang* 6860, 7 Nov. 1995 (RAMK).

Hypotrachyna masonhalei Patw. & Prabhu, *Bryologist* 80: 348 (1997)

This species was previously known only from India (Awasthi 1988, Patwardhan & Prabhu 1977). HPLC indicated that it contains atranorin (minor), chloroatranorin (minor), norstictic acid (major) and salazinic acid (major).

Specimen Examined

THAILAND. Chiang Mai Province: Doi Suthep-Pui, 18°49'N, 99°53'E, 1400 m, on *Diospyros* sp. in plantation, *T. Pooprang* 234/5, 5 March 1998 (RAMK).

Parmelinella chozoubae (Singh & Sinha) Elix & Pooprang, comb. nov.

Basionym: *Parmelina chozoubae* Singh & Sinha, *Nordic J. Bot.*, 13: 463 (1993).

This species was previously known only from Nagaland in India (Singh & Sinha 1993, 1994).

Specimens Examined

THAILAND. Chiang Mai Province: Doi Suthep-Pui, 18°49'N, 99°53'E, 1450 m, on bark of *Pinus kesiya* in mixed deciduous forest, *T. Pooprang* 3412, 8 Nov. 1994 (RAMK). Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 600 m, on bark of *Dipterocarpus* sp. in dry dipterocarp forest, *T. Pooprang* 6882, 7 Nov. 1995 (RAMK). Nakhon Ratchasima Province: Khao Yai National Park, 14°11'S, 101°11'E, 1400 m, on bark in evergreen forest, *T. Pooprang* 9707, 4 Nov. 1997 (RAMK). Phitsanulok Province: Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1400 m, on rock in evergreen forest, *T. Pooprang* 9480, 21 Oct. 1997 (RAMK).

Parmelinopsis horrescens (Taylor) Elix & Hale, *Mycotaxon* 29: 242 (1987)

A pantemperate and montane pantropical species which occurs on all continents except Antarctica.

Specimen Examined

THAILAND. Phitsanulok Province: Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1100 m, on bark in evergreen forest, *T. Pooprang* 12/22, 22 Feb. 1998 (RAMK).

Parmelinopsis microlobulata (Awas.) Elix & Hale, *Mycotaxon* 29: 242 (1987)

This species was previously known only from India (Awasthi 1977b).

Specimens Examined

THAILAND. Nakhon Sri Thammarat Province: Khao Luang National Park, 8°22'N, 99°40'E, 200 m, on bark in evergreen forest, *T. Pooprang* 9897, 18 Feb. 1998 (RAMK). Phitsanulok Province: Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1200 m, on rock in mixed deciduous forest, *T. Pooprang* 39/23, 23 Feb. 1998 (RAMK).

Parmelinopsis minarum (Vainio) Elix & Hale, *Mycotaxon* 29: 243 (1987)

A cosmopolitan species known from all continents except Antarctica.

Specimen Examined

THAILAND. Chiang Mai Province: Doi Suthep-Pui, 18°49'N, 99°53'E, 1400 m, on bark of *Pinus kesiya* in evergreen forest, *T. Pooprang* 207/5, 5 March 1998 (RAMK).

Parmeliopsis ambigua (Wulfen) Nyl., *Lich. lapp. Orient.*: 121 (1866)

A widely distributed species in boreal regions of the Northern Hemisphere. Also known from Australia.

Specimen Examined

THAILAND. Lumpang Province: Khuntan National Park, 18°25'N, 99°16'E, 1000 m, on bark in evergreen forest, *T. Pooprang* 278/6, 6 March 1998 (RAMK).

Parmotrema abessinicum (Kremp.) Hale, *Phytologia* 28: 334 (1974)

This species is widespread in Africa, and also reported from India (Awasthi 1988) and Central America.

Specimen Examined

THAILAND. Chiang Mai Province: Queen Sirikit Botanic Garden, 18°48'N, 98°58'E, 1000 m, on bark in mixed deciduous forest, *K. Boonpragob et al.* 1993, 28 June 1994 (RAMK).

Parmotrema corniculans (Nyl.) Hale, *Phytologia* 28: 335 (1974)

This species is known from Indonesia, Laos, the Philippines and Papua New Guinea (Kurokawa 1979).

Specimen Examined

THAILAND. Chiang Mai Province: Doi Inthanon National Park, 18°32'N, 99°29'E, 2000 m, on bark in evergreen forest, *T. Pooprang* 183/4, 4 March 1998 (RAMK).

Parmotrema elacinatum (Kurok.) Streim., *Bibliotheca Lichenologica* **22**: 94 (1986)

Previously this species was known only from Papua New Guinea (Kurokawa 1979) and Australia (Elix 1998).

Specimen Examined

THAILAND. Nakhon Ratchasima Province: Khao Yai National Park, 14°11'S, 101°11'E, 1400 m, on bark in evergreen forest, *T. Pooprang* 9711, 4 Nov. 1997 (RAMK).

Parmotrema hababianum (Gyeln.) Hale, *Phytologia* **28**: 336 (1974)

A widespread species known from Africa, North, Central and South America and from Asia (China and India) (Hale 1965a).

Specimen Examined

THAILAND. Chiang Mai Province: Doi Suthep-Pui, 18°49'N, 99°53'E, 1400 m, on bark of *Diospyros* in plantation, *T. Pooprang* 249/5, 5 March 1998 (RAMK).

Parmotrema incrassatum Hale ex DePriest & B. W. Hale, *Mycotaxon* **67**: 207 (1998)

Previously this species was only known from Hong Kong (DePriest & B. W. Hale 1998).

Specimen Examined

THAILAND. Chiang Mai Province: Queen Sirikit Botanic Garden, 18°48'N, 98°58'E, 1000 m, on bark in mixed deciduous forest, *T. Pooprang* 156/3, 3 March 1998 (RAMK).

Parmotrema overeemii (Zahlbr.) Elix, *Australasian Lichenology* **42**: 23 (1998)

Formerly this species was incorrectly known as *Parmotrema zollingeri* (Hepp) Hale (Elix 1998). It is a widespread species known from Africa, North, Central and South America and from Asia (Indonesia, Laos, Philippines, Taiwan) and the Pacific (Hale 1965a).

Specimens Examined

THAILAND. Chiang Mai Province: Queen Sirikit Botanic Garden, 18°48'N, 98°58'E, 700 m, on bark in dry dipterocarp forest, *T. Pooprang* 1540, 23 Jan. 1994 (RAMK); 1000-1200 m, *T. Pooprang* 2009, 2342, 2781, 28 June 1994 (RAMK); 700 m, *T. Pooprang* 2781, 28 April 1994 (RAMK); *T. Pooprang* 2972, 2994, 4 April 1994 (RAMK); *T. Pooprang* 160/3, 161/3, 3 Mar. 1998 (RAMK). Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 750 m, on bark of

Spondiac sp. in mixed deciduous forest, T. Pooprang 6210, 14 July 1995 (RAMK). Nakhon Ratchasima Province: Khao Yai National Park, 14°11'S, 101°11'E, 1400 m, on bark of *Mangifera indica* in plantation, T. Pooprang 7946, 7948, 19 Aug. 1997 (RAMK). Sakon Nakhon Province: Phu Pan National Park, 30°41'S, 30°16'E, 400 m, on bark in dry dipterocarp forest, T. Pooprang 291/23, 23 May 1998 (RAMK).

Parmotrema planatilobatum (Hale) Hale, *Phytologia* 28: 338 (1974)

This species has been reported previously from Africa (Krog & Swinscow 1981), Indonesia and Malaysia (Hale 1965b).

Specimen Examined

THAILAND. Nakhon Ratchasima Province: Khao Yai National Park, 14°11'S, 101°11'E, 1400 m, on bark of *Mangifera indica* in plantation, T. Pooprang 9712, 4 Nov. 1997 (RAMK).

Parmotrema pseudonigherrense (Asah.) Hale, *Mycotaxon* 5: 441 (1977)

This species has been reported from Australia (Elix 1994b), Africa, Nepal, Korea (Hale 1965a) and India (Awasthi 1977a).

Specimen Examined

THAILAND. Chiang Mai Province: Queen Sirikit Botanic Garden, 18°48'N, 98°58'E, 700 m, on bark *Dipterocarpus intricatus* in dry dipterocarp forest, K. Boonpragob et.al 994, 24 Jan. 1994 (RAMK).

Parmotrema subarnoldii (des Abbayes) Hale, *Phytologia* 28: 339 (1974)

A pantropical species known from Africa (Krog & Swinscow 1981), Central and South America (Hale 1965a), Australia, Indonesia and Papua New Guinea (Elix 1994b).

Specimens Examined

THAILAND. Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 500 m, on bark of *Shorea obtusa* in dry dipterocarp forest, T. Pooprang 7056, 8 Nov. 1995 (RAMK). Nakhon Ratchasima Province: Khao Yai National Park, 14°11'S, 101°11'E, 600 m, on bark of *Mangifera indica* in plantation, T. Pooprang 7952.2, 19 Aug. 1997 (RAMK).

Parmotrema sulphuratum (Nees & Flot.) Hale, *Phytologia* 28: 339 (1974)

This is a pantropical species known from Africa, Australia, North, Central and South America, Indonesia and Papua New Guinea (Elix 1994b).

Specimens Examined

THAILAND. Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 700 m, on bark in dry dipterocarp forest, *T. Pooprang* 6739, 6 Nov. 1995 (RAMK). Nakhon Sri Thammarat Province: Khao Luang National Park, 8°22'N, 99°40'E, 200 m., on bark of *Hevea brasiliensis* in plantation, *T. Pooprang* 9852, 17 Feb. 1998 (RAMK).

Relicinopsis malaccensis (Nyl.) Elix & Verdon, *Mycotaxon* 27: 282 (1986)

This is a widespread species in the lowland rainforests of tropical Africa, Australia, southern India, Sri Lanka, the Philippines, Malaysia, Indonesia and Papua New Guinea (Elix 1994c).

Specimens Examined

THAILAND. Loei Province: Nahaew National Park, 17°05'N, 101°05'E, 900 m, on rock in dry dipterocarp forest, *T. Pooprang* 5938, 6655,, 6774, 6775, 5 Nov. 1995 (RAMK). Phitsanulok Province: Phu Hin Rong Kla National Park, 16°59'N, 101°06'E, 1100 m, on bark in evergreen forest, *T. Pooprang* 25/22, 26/22, 111/24, 22 Feb. 1998 (RAMK).

Xanthoparmelia congensis (Stein) Hale, *Phytologia* 28: 486 (1974)

This species is also known from Africa, Australia and South America.

Specimens Examined

THAILAND. Lumpang Province: Khuntan National Park, 18°25'N, 99°16'E, 600 m, on rock in dry dipterocarp forest, *T. Pooprang* 274/6, 6 March 1998 (RAMK). Sakon Nakhon Province: Phu Pan National Park, 30°41'S, 30°16'E, 400 m, on rock in dry dipterocarp forest, *T. Pooprang* 290/7, 7 Oct. 1997 (RAMK).

Xanthoparmelia mougeotina (Nyl.) D. J. Galloway, *New Zealand J. Bot.* 18: 538 (1981)

This species is common in Australia and New Zealand.

Specimen Examined

THAILAND. Lumpang Province: Khuntan National Park, 18°25'N, 99°16'E, 900 m, on rock in evergreen forest, *T. Pooprang* 281/6, 6 March 1998 (RAMK).

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NEW RECORDS OF XYLARIACEAE OF SONORA, MEXICO

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ABSTRACT

Hypoxylon anthochroum, **H. polyporum**, **Xylaria microceras**, **X. pallide-ostiolata**, and **X. uniapiculata** are reported for the first time from the Mexican state of Sonora. Descriptions of **Xylaria microceras** and **X. uniapiculata** are enhanced by the communication of their cultural and anamorphic data. An artificial key to the known Sonoran Xylariaceae is provided.

Key words: Anamorph, **Daldinia**, **Hypoxylon**, México, **Xylaria**.

INTRODUCTION

In previous contributions to the knowledge of xylariaceous fungi found in the Mexican state of Sonora, Pérez-Silva et al. (1996) reported 16 taxa, San Martín et al. (1998) expanded the number to 20 by reporting **Daldinia eschscholzii** (Ehrenb.: Fr.) Rehm, **Xylaria feejeensis** (Berk.) Fr., **Xylaria poitei** (Lév.) Fr., and **Xylaria striata** var. **sonorensis** var. nov. In this contribution the species number in the state is increased to 25 by the additions of **Hypoxylon anthochroum** Berk. et Broome, **H. polyporum** (Starb.) Ju et J. D. Rogers, **Xylaria microceras** (Mont.) Fr., **X. pallide-ostiolata** Henn., and **X. uniapiculata** San Martín et J. D. Rogers. An artificial key to the Sonoran Xylariaceae known by us is provided.

Modes of collecting, preservation, and identification of taxa were as indicated in San Martín and Rogers (1995). Determination of colors in **Daldinia** spp. and **Hypoxylon** stromatal surfaces follow Kornerup and Wanscher (1967). Cultures and anamorphic information were obtained as given in San Martín and Rogers (1993). Herbarium designations are largely based on Holmgren et al. (1990).

Taxa included in the key, but not considered in the descriptive section, were reported in San Martín et al. (1998).

KEY TO XYLARIAACEAE COLLECTED IN SONORA UP TO THE PRESENT

1. Stromata turbinate to placentiform, sessile or with short, stout stipe; the interior composed of concentric rings. Surface reddish-brown (8-4B), blackened and varnished in age. Ostioles punctate. Ascospores brown to dark-brown, ellipsoid-inequilateral with narrowly rounded ends, (10.5-) 11-13 x 5-5.5 (-6.5) μm , with straight germ slit spore-length or nearly so and with dehiscent perispore in 10 % KOH **Daldinia eschscholzii**
1. Stromata sessile or stipitate. Interior without concentric rings 2
2. Stromata sessile, effuse-pulvinate, pulvinate or hemispherical. Ascospores with germ slit usually on convex side 3
2. Stromata stipitate, filiform to clavate. Ascospores with germ slit usually on concave side 4
3. Stromata effuse-pulvinate. Surface reddish-brown (8-C7). Ascospores brown to dark-brown, ellipsoid-inequilateral with narrowly rounded ends, 8.5-13.5 x 4-6 μm , with straight to slightly sigmoid germ slit spore-length **Hypoxylon anthochroum**
3. Stromata hemispheric. Surface reddish-brown (8-D6). Ascospores light-brown to brown, ellipsoid-inequilateral with narrowly rounded ends, (11-) 11.5-14 x 4.5-5.5 μm , with germ slit straight, less than spore-length **Hypoxylon polyporum**
4. Stromata usually 0.5 cm or greater in diameter 5
4. Stromata usually less than 0.5 cm in diameter 7
5. Fertile part clavate, with short or long stipe, sometimes with long rooting base, 3-7 cm total length x 0.5-1.5 cm diam, blackish, roughened with wrinkles and verrucae, with inconspicuous to discoid ostioles. Ascospores (22-) 23-26 (-28) x 7.5-8 (-9) μm , with short, oblique germ slit **Xylaria polymorpha**
5. Combination of features differing from above. Ascospores shorter with germ slit straight, spore-length 6
6. Fertile part broad clavate with rounded fertile apex, on long stipe, 6-11 cm total length x 0.8-1.5 cm diam, verrucose, black with white umbilicate to more or less hemispherical ostioles. Ascospores almost black, (14-) 15-17.5 (-18) x 5.5-6.5 (-7) μm , with narrow, acute or pinched ends **Xylaria pallide-ostiolata**
6. Fertile part clavate to irregular, on short to obsolete stipe, 5.5-21 cm total length x 2-4 cm diam, at first whitish and smooth but becoming blackish and rugose on drying, with hemispherical ostioles. Ascospores 14-17 (-18) x 5.5-6.5 μm , with narrowly rounded ends **Xylaria poitei**
7. Germ slit $\frac{1}{2}$ to $\frac{3}{4}$ ascospore length 8
7. Germ slit full or slightly less than ascospore length 9
8. Fertile part subglobose to clavate, with blunt to acute sterile apex, 0.5-4 cm total length x 1.5-3 mm diam, with outer layer split into brown strips or plaques. Ostioles umbilicate to slightly papillate. Ascospores light-brown to brown, ellipsoid-inequilateral with narrowly rounded ends, 12-15 (-17) x (4-) 4.5-6 μm **Xylaria arbuscula**
8. Fertile part branched, terete to flattened with acute sterile apices, up to 2.3 cm total length x 1.5-1.8 mm diam, with outer layer split in white or brown bands. Ostioles discrete to hemispherically papillate. Ascospores light-brown to brown, translucent, ellipsoid-inequilateral with narrowly rounded to acute or somewhat pinched ends, (11.5-) 12-14 (-15) x (4.5-) 5 (-5.5) μm **Xylaria striata** var. **sonorensis**
9. Fertile part unbranched or branched, cylindrical, with blunt to acute sterile apex, on short, smooth stipe, 2-4 cm total length x 1-2.5 mm diam, with white to tan outer layer usually split in bands. Ostioles finely conic-papillate. Ascospores light-brown to brown, ellipsoid to ellipsoid-inequilateral, with narrowly rounded ends, 8-11 (-12) x 3.5-4 μm ..

-**Xylaria microceras**
9. Combination of features differing from above. Outer layer brown to blackish 10
10. Fertile part unbranched to branched, cylindrical to cylindric-clavate, on short to long tomentose stipes that arise from pannose bases, 1.5 cm total length x 1-3 mm diam. Ostioles papillate, conspicuous and crowded. Ascospores brown to dark-brown, ellipsoid with narrow ends, with one end sometimes bearing a tiny cellular appendage, 8-9 (-10) x 4.5-5 μ m**Xylaria feejeensis**
10. Fertile part branched, cylindrical to irregular, on distinct stipe sometimes with discoid, pannose base, 2.5-5.5 cm total length x 2-3.5 mm diam. Ostioles papillate, strongly roughening surface. Ascospores brown, ellipsoid-inequilateral, usually with a minute hyaline cell on one end, 9-10 (-11) x (3.5-) 4 μ m**Xylaria uniapiculata**

DESCRIPTIONS

Hypoxylon anthochroum Berk. et Broome, J. Linn. Soc., Bot. 14: 122. 1873.

The species is as described by Ju and Rogers (1996).

SPECIMENS EXAMINED: Alamos municipality, Km 42 Alamos-Navjoa road, 2.V.1993, Esqueda 1198, on wood in low deciduous tropical forest (ITCV); San Javier municipality, Km 137.5 Hermosillo-Yécora road, 14.X.1995, Esqueda 2163, on wood in low deciduous tropical forest (ITCV); 17.II.1996, Esqueda 2606, on wood in low deciduous tropical forest (ITCV); Km 151, Hermosillo-Yécora road, 18.II.1996, Esqueda 2501, on wood in low deciduous tropical forest (ITCV); 15.III.1996, Esqueda 2516, on wood in low deciduous tropical forest (ITCV). Alamos municipality, Cuchujaqui river shore, 11.IX.1994, Pérez-Silva 1709, on wood in median subdeciduous tropical forest (ITCV); exit to the Uvalamas, 12.IX.1994, Pérez-Silva 1862, on wood in median subdeciduous tropical forest (ITCV).

NOTE: Previously, **H. anthochroum** was recorded from the states of Chiapas, Quintana Roo, Nuevo León, and Oaxaca (see Ju and Rogers [1996], for distribution of **H. anthochroum**).

Hypoxylon polyporum (Starb.) Ju et J. D. Rogers, Mycologia Mem. 20: 171. 1996.

The taxon is as described by Ju and Rogers (1996).

SPECIMEN EXAMINED: Alamos municipality, Cuchujaqui river shore, 11.IX.1994, Pérez-Silva 1703, on wood in low subdeciduous tropical forest (ITCV).

NOTE: **H. polyporum** was first encountered in a median subdeciduous tropical forest of Quintana Roo state. The species can also be found in Brazil and Malaysia (Ju and Rogers, 1996).

Xylaria arbuscula Sacc., Michelia 1: 249. 1878.

The material from Sonora is as described by San Martín and Rogers (1989). Cultures and anamorph were described by Rogers et al. (1988), and Callan and Rogers (1990).

SPECIMENS EXAMINED: Alamos municipality, exit to the Uvalamas, 12.IX.1994, Pérez-Silva 1802b and 1852, on wood in median subdeciduous tropical forest (ITCV).

ADDITIONAL SPECIMENS EXAMINED: China: Tonkin, Mont Bani, 1890, **Xylaria botrys** Pat. (TYPE; FH). México: Campeche state, Escárcega municipality, Ing. Eduardo Sangri Serrano Forestry Experimental Station, San Martín 1463 (CULTURED), on wood of **Bursera** sp. "copal colorado" in median subdeciduous tropical forest (ITCV; JDR). Chiapas state, Ocosingo municipality, ejido Loma Bonita, 22.VIII.87, San Martín 484, on wood in evergreen tropical forest (ITCV; JDR). Nuevo León state, Santiago municipality, El Cercado, 26.VI.88, Moreno 220; 23.X.88, San Martín 1145 (CULTURED), on dicot wood in

submontane scrub with *Quercus* spp. (ITCV; JDR). Oaxaca state, Temazcal town, 8.X.88, San Martín 1118, on wood in median subdeciduous tropical forest (ITCV; JDR). Quintana Roo state, Othón P. Blanco municipality, ejido La Unión, 1977, on *Swietenia macrophylla* King fruit (ITCV). Tabasco state, Cárdenas municipality, Colegio Superior de Agricultura Tropical, 7.XI.88, San Martín 1409 (CULTURED) & 1245, on wood of *Bactris baculifera* Karw. "jaguacaté" in an acahual (ITCV; JDR); La Venta town, 6.XI.88, San Martín 1422 (CULTURED), on dicot wood in an acahual (ITCV; JDR).

NOTES: *Xylaria arbuscula* is considered here as a taxon with wide host range, comprising a very diverse array of stromatal forms ranging from unbranched to much branched and from almost stunted to stipitate, but having in common light-brown to brown ascospores 12-15 (-17) μm long, with germ slit much less than ascospore length. The strongly zonate white and black colonies usually produce conidial stromata in concentric fashion that bear on their upper parts dusty-white areas of conidiogenous cells and conidia (5-) 5.5-7 (-8) $\times$ 1.5-2.5 μm (see San Martín, 1992 for cultural and anamorphic descriptions of *X. arbuscula* complex).

The type of *X. botrys* Pat. in FH fits the concept of *X. arbuscula* applied herein.

Xylaria microceras (Mont.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 128. 1851. Teleomorphic stromata and anamorph are much as described by Callan and Rogers (1990) and San Martín (1992).

Colonies at first white, somewhat floccose, zonate, with entire margins, becoming darkish from center outwards, felty. Stromata acuminate to clavate, produced more or less in concentric fashion or at random over-all the colony, unbranched to branched from the base, numerous, with blackish bases. Conidium-bearing regions on the surface of stromata. Conidia produced abundantly, hyaline (white to tan in mass), ellipsoid, (4.5-) 5-6 (-6.5) $\times$ 2 μm .

SPECIMENS EXAMINED: Alamos municipality, exit to the Uvalamas, 12.IX.1994, Pérez-Silva 1802a & 1838a, on wood in median subdeciduous tropical forest (ITCV); Alamos municipality, La Sierrita, 12.IX.1994, Pérez-Silva 1839, on wood in median subdeciduous tropical forest (ITCV).

ADDITIONAL SPECIMENS EXAMINED: Campeche state, Escárcega municipality, Ing. Eduardo Sangri Serrano Forestry Experimental Station, 9.XI.88, San Martín 1353 & 1445, on wood in an acahual; San Martín 1481 (CULTURED), on wood of *Adenocalyma hintoni* Sand. "bejuco blanco" in median subdeciduous tropical forest (ITCV; JDR). Chiapas state, Palenque municipality, Palenque Ruins, 8.XI.88, San Martín 1355, on wood in evergreen tropical forest (ITCV). Quintana Roo state, Othón P. Blanco municipality, Km 12 Cafetal-Mahahual road, 16.XI.88, San Martín 1446, on wood in low subdeciduous tropical forest with mangrove (ITCV; JDR); Sian Ka'an Biosphere Reserve, 15.XI.88, San Martín 1319 (CULTURED), on wood in median subdeciduous tropical forest (ITCV; JDR). Tamaulipas state, Aldama municipality, Nuevo Progreso, 31.VIII.88, San Martín 1089, on wood in a tropical forest of *Quercus oleoides* Cham. & Schlecht. (ITCV; JDR); Casas municipality, La Palma ranch, on wood in *Quercus* spp. forest (ITCV); Victoria municipality, Cañón del Novillo, 4.IX.88, Jesús García 6051 (CULTURED), on wood in tall scrub with tropical elements (ITCV; JDR).

NOTE: according to Laessøe (*in litt.*), material from northern Mexico is microscopically very similar to the type *X. microceras*, differing somewhat in the less granular outer peeling.

Xylaria pallide-ostiolata Henn., Engler's Bot. Jahrb. 38: 128. 1905.

Teleomorphic stromata are as described by San Martín and Rogers (1989). Asci cylindrical, eight-spored, with uniseriate spore-arrangement, 184-210 μm total length $\times$ 7.5-8 μm broad, the spore bearing part 114-125 μm .

SPECIMENS EXAMINED: Alamos municipality, Las Uvalamas ranch, 13.IX.1994, Pérez-Silva 1838b, on buried wood in low deciduous tropical forest (ITCV); San Javier municipality, km 151 Hermosillo-Yécora road, 19.IV.1996, Esqueda 2636, on buried wood in low deciduous tropical forest (ITCV).

ADDITIONAL SPECIMEN EXAMINED: Quintana Roo state, José María Morelos municipality, II.1986, Gonzalo Guevara 270, on wood in acahual (ITCV; JDR).

NOTE: *Xylaria pallide-ostiolata* seems to be rare in México. It was collected once in 1986 from the state of Quintana Roo, and as far as it is known, this is the second record for the country. Material from Sonora has tomentose clavae with white outer peeling layer organized in polygonal patches when young; the rest of characters are like typical *X. pallide-ostiolata* as described by Hennings (in Saccardo, 1910).

Xylaria uniapiculata San Martín and J. D. Rogers, Mycotaxon 34: 370. 1989

The teleomorph is as described by San Martín and Rogers (1989).

Colonies covering Petri dish in 2-3 weeks, at first white, with entire margins, azonate, velutinous to somewhat floccose, becoming dark-greenish from center outward. Reverse darkish. Stromata numerous, produced over the entire colony, acuminate to somewhat lanceolate, twisted, unbranched to branched at points of contact with Petri dish lid, 0.5-3 cm high x 1-1.5 mm diam, at first white then dark-green. Conidium-bearing regions on upper surfaces of stromata. Conidiophores in upright, loose palisades, branched or sparingly branched from bases, hyaline, smooth. Conidiogenous cells terminal, cylindrical with somewhat inflated apices, 7-22 x 2.5-4 (-5) μ m, bearing terminal and lateral conidial secession scars or terminal annellations. Conidia produced holoblastically. Conidiogenous cells proliferating in sympodial sequence or percurrently. Conidia hyaline (green in mass), smooth, ellipsoid, (9-) 10-13.5 (-15) x (3.5-) 4-4.5 (-5) μ m, with flattened bases indicating former points of attachment to conidiogenous cell. Some conidia with small, corona-like processes.

SPECIMENS EXAMINED: Alamos municipality, Cuchujaqui river shore, 14.IX.1991, Esqueda 506c, on wood in low deciduous tropical forest (ITCV); 11.IX.1994, Pérez-Silva 1719, on wood in low deciduous tropical forest (ITCV).

ADDITIONAL MATERIAL EXAMINED: Campeche state, Escárcega municipality, Ing. Eduardo Sangri Serrano Forestry Experimental Station, 9.XI.88, San Martín 1206, 1217, 1240, 1369, 1425, 1455 & 1492 on wood in median subdeciduous tropical forest (ITCV; JDR). Chiapas state, Jaltenango municipality, El Triunfo Hill-Cipresal hike trail, 10.VI.88, San Martín 907, on wood in cloud forest (ITCV; JDR). Oaxaca state, Temazcal town, 7.X.88, San Martín 1059, on wood in median subdeciduous tropical forest (ITCV; JDR). Quintana Roo state, Othón P. Blanco municipality, San Felipe Bacalar, 10.XI.88, San Martín 1221 & 1222; 16.XI.88, San Martín 1456, on wood in acahual; Sian Ka'an Biosphere Reserve, 15.XI.88, San Martín 1270, 1296 (CULTURED), 1298 (CULTURED), & 1301, on wood in median subdeciduous tropical forest (ITCV; JDR). Tamaulipas state, Aldama municipality, Barra del Tordo, 1.IX.88, San Martín 1104; Ocampo municipality, Santa María Guadalupe Colony, 2.VIII.87, San Martín 527; X.87, San Martín 459 (CULTURED); 16.V.88, San Martín 637 & 668; El Tigre Hill, 8.VIII.88, S. Chacón 474; San Martín 991, on wood in median subdeciduous tropical forest (ITCV; JDR); Gómez Farias town, VII.87, San Martín 621; 12.VIII.87, San Martín 621B & 632; 2.IX.88, San Martín 1042 & 1051 (CULTURED); 15.IX.88, San Martín 1015 & 1016, on wood in median subdeciduous tropical forest (ITCV; JDR).

NOTES: Collections from northeast and southeast Mexico are typical of the species. It is interesting to note that *X. uniapiculata*, *X. longipes* (Rogers, 1983) along with *Daldinia*

occidentalis Child (Petrini and Müller, 1986) (= **Daldinia petriniae** Y.-M. Ju, J. D. Rogers and San Martín) and some other fungi, notably members of Diatrypaceae (Glawe, 1989), can switch from sympodial to percurrent conidiogenous cell proliferation.

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AN HISTORICAL SURVEY OF HYMENANGIUM ALBUM, RHIZOPOGON ALBUS AND TUBER ALBUM

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Abstract

Based on the protologues and herbarium collections, we confirm that the names *Hymenangium album* and *Rhizopogon albus* refer to the species *Descomyces albus*. In agreement with early authors, *Tuber album* is synonym of *T. borchii*.

Resumen

En base a las descripciones originales y en el estudio de material de herbario, confirmamos que los nombres *Hymenangium album* and *Rhizopogon albus* hacen referencia a una misma especie, *Descomyces albus*. De acuerdo con autores anteriores, *Tuber album* es sinónimo de *T. borchii*.

Introduction

In a previous paper (Martín, 1997), we stated that some collections located in various herbaria and labelled under the name *Rhizopogon albus* Fr. do not belong to this taxon. We identified them as *Choiromyces meandriformis* Vitt. (Ascomycotina), *Bovista colorata* (Peck.) Kreisel, *Scleroderma bovista* Fr. and *Scleroderma citrinum* Pers. (Basidiomycotina). We expand upon the history of *Rhizopogon albus*, and its relation with *Hymenangium album* and *Tuber album*, based upon herbarium collections and historical literature housed in PC.

Historical survey

Bulliard (1791) in his *Histoire des Champignons de la France*, describes the species *Tuber album* as: "*Tuber albo-subrufescens; radice destitutum, sed basi radicati instructum*", including a plate (pl. 404) with drawings of several

basidiomes. In the description, he mentions that the peridium can be smooth, as observed in basidiomes sent by Saint-Amans from Agen (Figs. A-B, pl. 404), or rugous, as in the basidiomes he collected from the Rambouillet forest (Figs. C-F, pl. 404). Bulliard does not give microscopic characters; however, based on the peridial drawings of this plate there are no doubts that his description of *Tuber album* is based upon two collections that belong to two different taxa. What species are they?. Do they belong to *Ascomycotina* or to *Basidiomycotina*?

Persoon (1801) and Lamarck & De Candolle (1815), accept *Tuber album* Bull., as a good species and mention *Lycoperdon gibbosum* Dick. (Dickson, 1790) as a synonym of this species. Fries (1823), in his *Systema Mycologicum* (volume II), describes the new species *Rhizopogon albus* as: “*Minor, subrotundus, oblongus, parum difformis, leviter flocculosus, extus ex albo sordide rufus, intus albus, dissectus ad aëris contactum rubescens. Basis radicalis fibrillosa. Cf. Tuber rufum*”. He mentions *Lycoperdon gibbosum* Dick. and *Tuber album* Bull. as synonym of his species. However later, Fries (1835) reported that his *Rhizopogon albus* was not *Tuberi albus* Bull. ss. Krumboltz.

In 1836, Berkeley mentioned a collection of *Rhizopogon albus* Bull. from Glasgow giving the following macroscopic characters: “*round, rather rugged, whitish then reddish-brown slightly fibrillose at the base*”. He also mentions some important microscopic characters: “*Sporidia ochraceous, reddish-brown, exactly resembling in shape a lemon*”. Klotzsch (1839), under the same set of microscopic characters, describes a new species, *Hymenangium album* Klotzsch. which was combined to *Hymenogaster albus* (Klotzsch.) Berk. by Berkeley (1844).

According to the description and figures of *Rhizopogon albus* Fr. ss. Corda (1841), this is without doubt an *Ascomycotina*. In agreement with Švrček (1958), its microscopic characters are very close to those of *Choiromyces meandriformis* Vittad. (t. IV, fig. 10; Vittadini, 1931)

Lespiauult (1844) in his “*Note sur le Tuber album de Bulliard*, gives the first light about this Bulliard’s species. He collected white truffles in the same localities where the collections published by Bulliard (Fig. A-B, pl. 404) were located. He was sure about the identity because, around Nérac and in the whole Lot-et-Garonne, the only truffle species that people eat has basidiomes like those he collected. On the other hand, Saint-Amans who sent to Bulliard the basidiomes used to draw the figures A-B, confirmed to Lespiauult that his collections from Nérac were the same truffle that farmers from Agen eat,

boiled in white wine. Lespiault gives a description and iconography of his collections both macro and microscopic. The asci are globose with one to four ascospores which show reticulate ornamentation. There is no doubt that *Tuber album* Bull. ss. Lespiault belongs to the actual genus *Tuber* Micheli. After studying one of the collections stored at PC, collected by Lespiault in Nerac and, according to the envelope, revised in 1994 by Moreno, we consider that they fit with *Tuber borchii* Vitt. ss Montecchi (Montecchi & Lazzari, 1993). These last authors include *T. album* Bull. as a synonym of *Tuber borchii* Vitt.

What species is represented in the figures C-G in Bulliard's plate 404?. According to Lespiault (1844), these figures look similar to *Balsamia vulgaris* Vitt. However, we have not located any collection in the herbaria consulted from Rambouillet forest and collected by Bulliard. This would be the only way to be sure about the taxon shown in the figures mentioned.

On the other hand, and coming back to the problem of *Rhizopogon albus* Fr. ss. Fries (1823), Fries (1846) recognized the mistake made in his *Systema Mycologicum* and considered *Rhizopogon albus* Fr. as a synonym of *Hymenogaster albus* (Klotzsch) Berk. According to Bougher & Castellano (1993) the correct name for this species is *Descomyces albus* (Klotzsch) Bougher & Castellano.

Taxonomic conclusions

In agreement with Montecchi & Lazzari (1993), *Tuber album* Bull. is synonymous with *T. borchii* Vittad. Even though the first name is older it is invalid. Plate 404 in Bulliard (1791) illustrates two different taxa, thus the name is not validly published. The correct name is *T. borchii* Vittad.

If the division of the genus *Hymenogaster* Vittad. proposed in Bougher & Castellano (1993) is accepted, *Descomyces albus* (Klotzsch) Bougher & Castellano is the valid name for *Rhizopogon albus* Fr. ss. Fries (1823), *Hymenangium album* Klotzsch and *Hymenogaster albus* (Klotzsch) Berk.

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BULBOTHRIX SIPMANII, A NEW LICHEN SPECIES FROM GUYANA

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Abstract: The new species *Bulbothrix sipmanii* Aptroot & Aubel is described on the basis of a collection from Guyana. It resembles *B. schiffneri* in having narrow lobes with many branched cilia and coronate apothecia with conspicuously lunate ascospores, but differs by the presence of isidia. It is probably the isidiate counterpart of that species.

Introduction: *Bulbothrix* species are particularly characteristic epiphytes of open, savannah-like habitats, and are most diverse in the neotropics (Hale 1976). They are closely adnate, minutely foliose, bicorticate, with black, bulbate cilia. Apothecia are often coronate (with reduced rhizines on the margins), a character which is otherwise only known from species of the genus *Relicina*. Only a few neotropical species of these two genera possess these characteristic lunate, bicornute ascospores.

Material and methods: Chemical analysis was carried out by Thin Layer Chromatography (TLC) on Merck 60F-254 precoated plates with the solvent systems A & B. Spots were visible before and after being subjected to shortwave (254 micrometer) and longwave (350 micrometer) UV, and also after charring and re-examination with longwave UV, and fatty acid spots were detected after spraying with acid and aqua dest. The ascospores were measured before and after squashing; cornute, semilunate spores are measured from tip to tip, regardless of the degree of curvature. All microscopic features of the species were measured with a gauged ocular micrometer.

Bulbothrix sipmanii Aptroot & Aubel, sp. nov.

Plate 1

Type: Guyana, East Demerara district, Tihmeri, Dakara Creek, Thompson's farm, in cultivated, open area, on free standing tree, on branch, alt. ca. 10 m, coord. 6°29' N, 58°15' W, 2-II-1985, H. Sipman & A. Aptroot 18032 (U holotype; B, TNS, US isotypes).

Bulbothrix lobis usque ad 0.5 mm latis, isidiis institutis; sporiis bicornutis, semilunatis, aliquando tordato; acidum atranorinum et gyrophoricum continens.

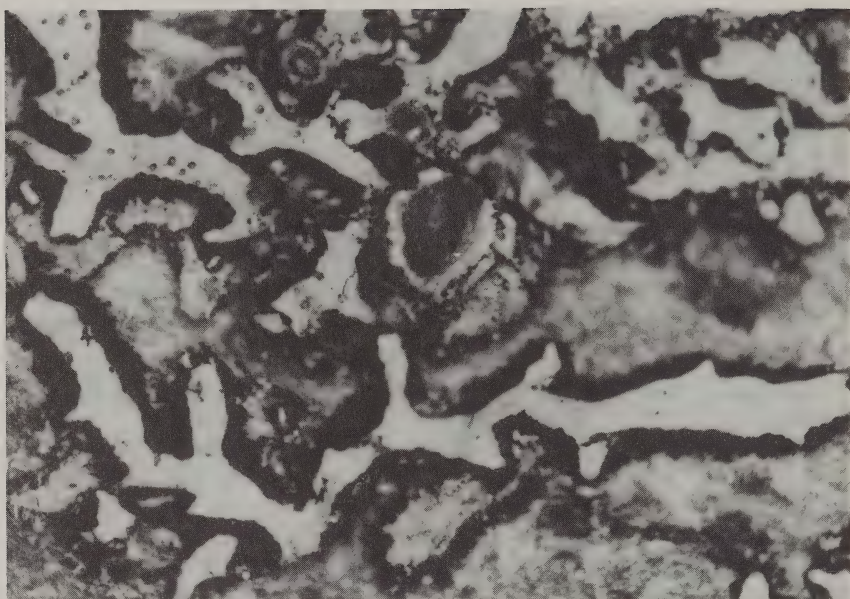


Plate 1. *Bulbothrix sipmanii* — type, habitus; 3 cm = 1 mm.

Thallus corticolous, greenish grey, up to 2 cm in diameter. Lobes irregularly branched, sublinear to linear, 0.2–0.5 mm wide, lateral tips acute, at the periphery obtuse to truncate, surrounded by a dense layer of cilia. Cilia bulbate, one to five times dichotomously branched, occasionally simple, up to 0.2 mm long and up to 25 μm diam.; bulbae up to 75 μm diam. Isidia sparse, laminal, simple, up to 0.3 mm long and up to 50 μm diam., tips brown to black, sometimes ciliate. Soralia, lobules and pustules absent. Upper surface in the centre cracked. Medulla white. Lower surface in the centre black, at the periphery brown. Apothecia imperforate, lecanorine, sessile, 1–1.5 mm in diameter, disc brown, hymenium colourless, 40–90 μm thick asci clavate. Hypothecium and parathecium colourless. Ectal exciple smooth and concolorous with the upper surface, coronate. Spores 8 per ascus, colourless, unilocular, (8–)14–18(–24) $\times$ (2.5–)3.5–4(–5) μm , bicornute, semilunate, sometimes tordate. Chemistry: Colour reactions: medulla K–, C+ pink, KC+ pink, P–, UV–; cortex K+ yellow, UV–. TLC: atranorin, gyrophoric acid.

Discussion: The new species resembles *B. schiffneri* in possessing narrow lobes with many branched cilia and coronate apothecia with conspicuously lunate ascospores, but differs by the presence of isidia. *B. sipmanii* is probably the isidiate counterpart of *B. schiffneri*. The extraordinary ascospore form was found to be a constant character, as was the case in studied material of other *Bulbothrix* species (e.g. *B. semilunata* (Lynge) Hale; Brazil, Minas Gerais, Caraça, Aptroot 40811, Sept. 1997, ABL). The species is named in honour of dr. H.J.M. Sipman, lichenologist and collector from the Netherlands.

Reference: Hale, M.E. (1976) A monograph of the lichen genus *Bulbothrix* Hale (Parmeliaceae).— *Smithsonian Contributions to Botany* 32: 1–29.

THE TAXONOMIC BOUNDARIES BETWEEN NAUCORIA RHEOPHYLLA AND SETCHELLIOGASTER TENUIPES BASED ON MORPHOLOGICAL AND MOLECULAR DATA

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Abstract

Based on morphological and molecular characters, we state that *Setchelliogaster tenuipes* (secotioid) is recently derived from *Naucoria rheophylla* (agaricoid).

Resumen

Basándonos en estudios morfológicos y moleculares, consideramos que *Setchelliogaster tenuipes* (secotioide) es una especie derivada de *Naucoria rheophylla* (agaricoide).

INTRODUCTION

Recently, MORENO *et al.* (1997) transferred *Descolea rheophylla* (Bertault & Malençon) Malençon (= *Naucoria rheophylla* Bertault & Maleçon) to the genus *Setchelliogaster* Pouzar. Moreover, these authors state that the basidiomes described in CALONGE *et al.* (1995) under the name *Setchelliogaster tenuipes* (Setchell) Pouzar were misidentified, considering that they belong to the species *S. rheophylla*. On the other hand, they reexamined the material mentioned in VIDAL (1994) as *S. tenuipes* and one collection from Italy (AH 18401), identified by Mario Sarasini, also under *S. tenuipes*; concluding that the characters of these collections are in accordance with those mentioned in *S. tenuipes* protologue (*Secotium tenuipes* Setchell).

According to MORENO *et al.* (1997), the main characters to differentiate between *S. rheophylla* and *S. tenuipes* are the kind of development of the basidiome (hemiangiocarpous vs. angiocarpous), the type of hymenophore

(lamellar vs. labyrinthiforme) and the presence or not of cheilocystidia (abundant vs. none).

Both taxa have been introduced in Europe and USA together with *Eucalyptus* spp. MALENÇON & BERTAULT (1970) collected *N. rheophylla* basidiomes in Morocco under these trees; also, SETCHELL (1907) mentions that the basidiomes of *S. tenuipes* were found in California under *Eucalyptus* spp. or close to them. The same habitat is mentioned in ESTEVE-RAVENTÓS *et al.* (1997) and VIDAL (1994) for these species in Spain. In the rest of Europe, *N. rheophylla* and *S. tenuipes* have been cited only in Italy under the same introduced host (PACIONI, 1980; PACIONI & LALLI, 1984; MONTECCHI & LAZZARI, 1993).

In 1995, we collected, in a *Eucalyptus* plantation in Girona, basidiomes with hemiangiocarpous development that fit MALENÇON & BERTAULT's (1970) description of *Naucoria rheophylla*; but, these basidiomes were growing very close to angiocarpous basidiomes that fit with *S. tenuipes*.

Many authors have established the relationships between agaricoid and gasteroid genera. Thus, MALENÇON (1931) postulated in the *Russulaceae* a natural series, "the Asterospores", that constitute a natural grouping of genera with exceedingly close affinities in spite of apparent dissimilarities in their extreme forms. MALENÇON (1931) considers that the genera *Lactarius* and *Russula* (agaricoid) are the starting point and the other genera, such as *Macowanites* (gasteroid), have suffered a morphological regression. MARTÍN *et al.* (1998) based on morphological and molecular data of basidiomes of *Russula messapica* Sarnari and *Macowanites messapicoides* Llistosella & Vidal collected under the same *Quercus ilex* concluded that *Macowanites messapicoides* is recently derived from *Russula messapica*.

The 1995 material of *Naucoria rheophylla* and *Setchelliogaster tenuipes* gave us the opportunity to examine variation not only in morphological characters, but also, using molecular tools, in sequences of the ITS rDNA between specimens collected the same day, under the same tree. We have included in this study other collections, as well as the type material of both taxa.

MATERIAL AND METHODS

Material

Eight collections were examined to define the macroscopic and microscopic characters:

Naucoria rheophylla Bertault & Malençon.- MARROC: Cherf-el-Akab, close to Tanger, under *Eucalyptus* and *Olea*, 30.03.1964, leg. G. Malençon & R. Bertault (PARATYPE, MPU); SPAIN: Gironés (Llagostera, Can Roura), under *Eucalyptus*, 10.02.95, leg. A. Rocabruna, M. Tabarés & J. Vila (BCC-MPM 2705), growing close to *Setchelliogaster tenuipes* BCC-MPM 2704.

Setchelliogaster tenuipes (Setchell) Pouzar.- USA: Alameda County, University of California campus, 12.12.1904, *Gardner* 229, (HOLOTYPE, MICH).- Santa Clara Co., Campus of Stanford University, under *Eucalyptus* tree, 03.05.1942, leg. W.B.Cooke & M. Doty, det. W.B.C., *Mycobiota of North America* 138, ex herbario Wm. Bridge Cooke (TOPOTYPE, MICH).- Alameda County, in *Eucalyptus* grove, 25.03.1911, leg. M.B. Nichols, *California Fungi* 399 (MICH).- SPAIN: Gironés (Llagostera, Can Roura), under *Eucalyptus*, 03.02.96, leg. A.Rocabrana (BCC-MPM 2702).- Gironés (Llagostera, way to Sant Feliu), under *Eucalyptus*, 06.12.95, leg. A.Rocabrana & M. Tabarés (BCC-MPM 2703).- Gironés (Llagostera, Can Roura), under *Eucalyptus*, 10.02.95, leg. A. Rocabrana, M. Tabarés & J. Vila (BCC-MPM 2704), growing close to *Naucoria reophylla* BCC-MPM 2705.

Morphological characters

Specimens were reexamined to define the macroscopic and microscopic characters, following the criteria of SINGER & SMITH (1959), MALENÇON & BERTAULT (1970) and MALENÇON (1979). Type specimens were prepared for SEM according to MARTÍN & ROCABRUNA (1988) and studied under a Hitachi S-2300 SEM.

Molecular analysis

Total DNA was isolated according to HENRION *et al.* (1992) and HENRION *et al.* (1994) with the modifications indicated in MARTÍN *et al.* (1998); from the typus material less than 20 µg were included in each isolation.

Primer pairs ITS1/ITS4 and ITS1F/ITS4 were used to obtain amplifications of the both ITS regions, including the 5.8S of the ribosomal RNA gene cluster; primer pairs ITS1F/ITS2 and ITS3/ITS4 were used to obtain separately amplifications of ITS1 and ITS2 regions. Primers were described in WHITE *et al.* (1990) and GARDES & BRUNS (1993). Amplifications were done using PCR Beads from Pharmacia-Biotech (WINKA *et al.* 1998). Results of amplifications were assayed from 5 µl aliquots by gel electrophoresis of 1% ME-Agarose (Seakem, FMC Bioproducts).

From all the products obtained, both strands were sequenced using the AmpliTaq DNA Polymerase FS Dye Terminator Cycle Sequencing kit (Perkin Elmer) with an Applied Biosystems 377 Automatic sequencer (Foster City, CA, USA).

RESULTS AND DISCUSSION

Morphological characters

Macroscopic and microscopic characters of our collections previously identified as *Naucoria rheophylla* and *Setchelliogaster tenuipes* are in

accordance with those observed in the type material. Moreover, our observations are in agreement with those in MORENO *et al.* (1997). Thus, no tibiiform hymenial cystidia were observed in the gasteroid collections of *S. tenuipes*, including the type material, and the pileipellis (over 100 µm high) is formed by hyaline cells (up to 20 µm diameter) where the inner show rusty brown incrustated pigments. However, no clear differences under optical or scanning electron microscope were observed between spores of both taxa under study. In basidiomes of *N. rheophylla* (BCC-MPM 2705) and *S. tenuipes* (BCC-MPM 2704), collected under the same tree, spores were identical to those illustrated in MORENO *et al.* (1997) to *S. rheophylla*. Moreover, in the three Spanish collections of *S. tenuipes*, it was possible to observe basidia and they had the same shape, size and sterigmata as those in *N. rheophylla* (BCC-MPM 2705) and illustrated by early authors for both *S. tenuipes* (POUZAR, 1958; SINGER & SMITH, 1959; MIGLIOZZI & COCCIA; 1987) and *N. rheophylla* (MALENÇON & BERTAULT, 1970; PACIONI & GALLI, 1984; ESTEVE-RAVENTÓS *et al.*, 1997), including the microscopic photography of *S. rheophylla* in MORENO *et al.* (1997).

Molecular data

No successful amplifications of the ITS rDNA were gotten from any of the collections included in this study. Amplifications of the ITS1 and ITS2 regions from the type collections of both taxa were obtained only with primer pairs ITS1F/ITS2 and ITS3/ITS4; however, unfortunately, they were not good enough to obtain readable sequences. The ITS regions including the 5.8S rDNA were successfully amplified using ITS1/ITS4 from 4 basidiomes: BCC-MPM 2705 (*N. rheophylla*) and BCC-MPM 2702, 2703, 2704 (*S. tenuipes*). Both strands sequences were obtained from three of these specimens. The consensus sequences have been submitted to EMBL GenBank with the Accession Numbers AF099361 (BCC-MPM 2705), AF099362 (BCC-MPM 2704) and AF099363 (BCC-MPM 2703).

The alignment of the three sequences is shown in Fig.1 where they are coded as REONAU-1 (*N. rheophylla*, BCC-MPM 2705), TENSET-4 (*S. tenuipes*, BCC-MPM 2703) and TENSET-3 (*S. tenuipes*, BCC-MPM 2704). Alignment resulted in 594 sites, without ambiguous areas. The nucleotide differences among all pairwise comparisons for the ITS1 and ITS2 sites are summarised in Table 1; there were no differences in the 5.8S rDNA gene.

Table 1. Percent sequence divergences in ITS1 and ITS2 from pairwise comparison among isolates.

Pairwise comparison	ITS1	ITS2
REODES-1 vs. TENSET-4	11.8 %	7.8 %
REODES-1 vs. TENSET-3	12.3 %	8.3 %
TENSET-4 vs. TENSET-3	6.5 %	6.5 %

REODES-1	GAATCATGTC	GGTAGGtTGC	AG-ggCTGCA	CGAGCAGCAT	GTGCAAGACG
TENSET-3	GA-TAA-CTG	GGTGGGTGT	AGTGGCTCTT	TCGGGAGCAT	GTGCACGCCC
TENSET-4	GAATAA-CTT	GG-GGGT-GA	AGTGGTTGAT	T-GGGAGCAT	GTGCACGCCC
REODES-1	GATGAAGATT	ATCTTTCTAC	CTGTGCACCC	-TTTGTAAGA	CTTGGAATTC
TENSET-3	G-TCAC-TTT	ATCTTTCCAC	CTGTGCACCC	-TTTGTA-GA	CTTGGAATTC
TENSET-4	G-TCACATTT	ATCTTTGTAG	CTGTGCAGCC	ATTTGTA-GA	CTTGGAATTC
REODES-1	AAACCCaTTC	T-GAAAGGCT	CGCCTTTTAG	TATGAGGGAT	TGCCATCGGG
TENSET-3	AAAnCC-TTC	T-GAAAGGCT	CGCCTTTTAG	TATGAGGGAT	TGCCATCGGG
TENSET-4	AAAACC-TTC	TAGAAAGGCT	CGCCTTTTAG	TATGAGGGAT	TGCCATCGGG
REODES-1	CTTCCCTTGT	GGGTTTCAAG	TCTATGTTTT	TCATATACCC	CATAGTAAAA
TENSET-3	CTTCCCTTGT	GGGTTTCAAG	TCTATGTTTT	TCATATACCC	CATAGTAAAA
TENSET-4	CTTCCCTTGT	GGGTTTCAAG	TCTATGTTTT	TCATATACCC	CATAGTAAAA
REODES-1	TCCTAGAATG	TAATCAAAGG	CCTCTGTGCC	TATAAAAAAA	GTTATACA <u>CAAC</u>
TENSET-3	TCTTAGAATG	TAATCAAAGG	CCTCTGTGCC	TATACAAAAA	GTTATACAAC
TENSET-4	TCTTAGAATG	TAATCAAAGG	CCTCTGTGCC	TATACAAAAA	GTTATACAAC
REODES-1	<u>TTTCAGCAAC</u>	<u>GGATCTCTTG</u>	<u>GCTCTCGCAT</u>	<u>CGATGAAGAA</u>	<u>CGCAGCGAAA</u>
TENSET-3	TTTCAGCAAC	GGATCTCTTG	GCTCTCGCAT	CGATGAAGAA	CGCAGCGAAA
TENSET-4	TTTCAGCAAC	GGATCTCTTG	GCTCTCGCAT	CGATGAAGAA	CGCAGCGAAA
REODES-1	<u>TGCGATAAGT</u>	<u>AATGTGAATT</u>	<u>GCAGAATTCA</u>	<u>GTGAATCATC</u>	<u>GAATCTTTGA</u>
TENSET-3	TGCGATAAGT	AATGTGAATT	GCAGA-TTCA	GTGAATCATC	GAATCTTTGA
TENSET-4	TGCGATAAGT	AATGTGAATT	GCAGAATTCA	GTGAATCATC	GAATCTTTGA
REODES-1	<u>ACGCACCTTG</u>	<u>CGCTCCTTGG</u>	<u>TATTCCGAGG</u>	<u>AGCATGCCTG</u>	<u>TTTGAGTGTC</u>
TENSET-3	ACGCACCTTG	CGCTCCTTGG	TATTCCGAGG	AGCATGCCTG	TTTGAGTGTC
TENSET-4	ACGCACCTTG	CGCTCCTTGG	TATTCCGAGG	AGCATGCCTG	TTTGAGTGTC
REODES-1	<u>ATTAAATTCT</u>	CAACCTTATC	AT-CTTCGAT	GGCAAGGCTT	GGACTTGGGG
TENSET-3	ATTAAATTCT	CAACCTTATC	AT-CTTCGAT	GGCAAGGCTT	GGACTTGGGG
TENSET-4	ATTAAATTCT	CAACCTTATC	ATTCTTCGAT	GGCAAGGCTT	GGAATTGGGG
REODES-1	GATTTGCGGG	CTTCCCTTTT	TGAAGTCGGC	TCCTCTTAAA	TGAATTAGCG
TENSET-3	GATTTGCGGG	CTTCCCTTTT	TTGAGTCGGC	TCCTCTTAAA	TGAATTAGCG
TENSET-4	GATTTGCGGG	CTTCCCTTTT	AGAAGTCGGC	TCCTCTTAAA	TGAATTAGCG
REODES-1	GGAAAACGAA	AACCGTCTAT	TGGTGTGATA	ATTATCTACG	CCGTTGTGAC
TENSET-3	GGAAAACGAA	AACCGTCTAT	TGGTGTGATA	ATTATCTACG	CCGTTGTGAC
TENSET-4	GGAAAACGAA	AACCGTCTAT	TGGTGTGATA	ATTATCTACG	CCGTTGTGAC
REODES-1	TACTTTTCGAG	TTTGCTGATT	-CAAACCGTC	CTTAA-GGAC	AATCGGTGAA
TENSET-3	-ACTTTTCGAG	TTT-CTGATT	GCAAACCGTC	CTTAG-GGAC	AATCCATTAA
TENSET-4	TACTTTCCAG	TTT-CTGCTT	-CAAAGCGTC	CTTAGGGGAC	A-TC-ATTAA
REODES-1	-GATCATTAG	ACCTC-GGTG	AGGC		
TENSET-3	TGAACATT-G	AACCTCAATC	AGGT		
TENSET-4	TGATCATTTG	ACCTCAATC	AGGT		

Fig. 1 Alignment of the ITS' 1 and ITS 2 sequences, including the 5.8S rDNA (underlined)

In general, and particularly in fungi, the ITS 1 region of ribosomal RNA is highly variable even among closely related taxa. KRETZER & BRUNS (1997) investigated the secotiid genus *Gastrosuillus* to clarify its relationships with *Suillus*. Their alignment resulted in several ambiguous areas; however, the analysis of the unambiguous sites allowed them to transfer all known *Gastrosuillus* species to *Suillus*. In eight *Trichaptum* specimens, KO, HONG & JUNG (1997) found that the sequences of the ITS1-5.8S-ITS2 regions were very variable, even in their length. In the ITS1 region, from the 460 positions, only 101 were optimally aligned and in the ITS2 region, from the 278 positions, 209 sites were optimally aligned. As shown in Fig. 1, the alignment among our isolates has no unambiguous parts and, although the sequence dissimilarities are too high, mainly in the ITS 1 region, there is no doubt that both taxa should belong to the same genus as clearly stated in MORENO *et al.* (1997). We would like to move nearer the boundaries among these taxa suggesting that, according to morphological and molecular data, *Setchelliogaster tenuipes* is recently derived from *Naucoria rheophylla*. Additional sampling from other populations is needed to adequately address this issue; however, other authors have observed a continuum in morphotypes which transgresses the current formal taxonomic boundaries. Thus, BOUGHER *et al.* (1993) found a large diversity among basidiomes of *Hydnangium sublamellatum*, ranging from hypogeous or subepigeous, angiocarpous, truffle-like to epigeous, hemiangiocarpous, agaricoid basidiomes that approach the morphology of *Laccaria* species. HIBBETT *et al.* (1994) examined ontogeny and heritability of the secotiid phenotype in *Lentinus tigrinus* with a combination of formal genetic crosses, scanning electron microscopy and macroscopic observation of cultured basidiomes, and they stated that the secotiid morphology in *L. tigrinus* was controlled by a recessive allele at a single locus.

The presence under the same tree of basidiomes with agaricoid (*Naucoria reophylla*) and gasteroid (*Setchelliogaster tenuipes*) morphotypes had not been reported before in Spain, Italy, Morocco or USA, but it seems to be a phenomenon quite frequent in natural populations of *Eucalyptus* spp. in Australia (Bougher, com. personal). Based on ecological, morphological and molecular data, we could conclude that the agaricoid basidiomes of *N. reophylla* and the gasteroid of *S. tenuipes* are two morphotypes of the same species. However, they differ in an important taxonomic character: the tibiiforme cheilocystidia are not present in *S. tenuipes*.

It would be necessary to study more collections of *N. reophylla* and *S. tenuipes*, as well as other taxa described under *Naucoria* (Fr.) P. Kummer (1871) and *Setchelliogaster* Pouzar (1958), both their morphology and ITS sequences of the ribosomal rDNA gene, to clearly state the taxonomic boundaries around both genera.

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MELIOLACEAE OF KERALA, INDIA - VI

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Summary

This paper gives an account of four Meliolaceae members. Of these, *Asteridiella schumannianthi* and *Meliola frutescentis* are new species. *Irenopsis crotonis* (Stev. & Tehon) Stev. and *I. molleriana* (Wint.) Stev. are the first reports from India.

1. *Asteridiella schumannianthi* sp. nov.

(Fig. 1)

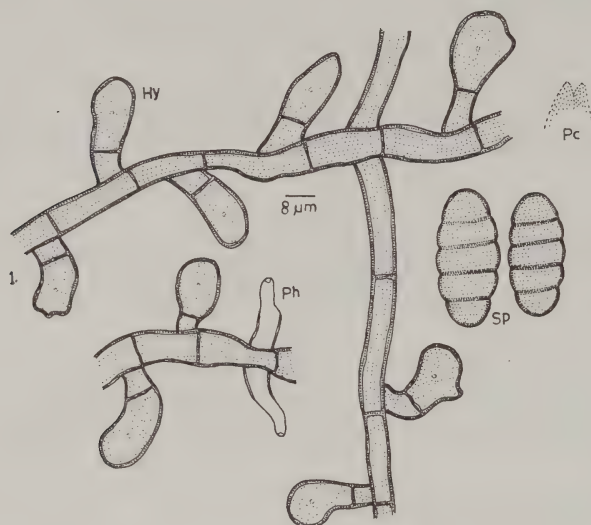
Coloniae amphigenae, tenues vel subdensae, ad 3 mm diam., raro confluentes. Hyphae rectae vel flexuosae, oppositae vel irregulariter acuteque vel laxae ramosae, laxae reticulatae, cellulae $12-18 \times 6-7 \mu\text{m}$. Hyphopodia alternata, recta vel curvula, leniter remote posita, antrorsa, subantrorsa vel retrorsa, $22-24 \mu\text{m}$ longa; cellula basali cylindracea vel cuneata, $7-9 \mu\text{m}$ longa; cellula apicali ovata, globosa, integra, angularia, truncata, raro leniter lobata, $14-16 \times 9.5-14.5 \mu\text{m}$. Phialides modice numerosae, mixtae cum hyphopodia, alternatae vel oppositae, ampullaceae, $14-18 \times 6-7 \mu\text{m}$. Perithecia dispersa, ad $140 \mu\text{m}$ diam.; cellulae peritheciales conoideae, ad $12 \mu\text{m}$ longae; ascosporae cylindraceae vel ellipsoideae, 4-septatae, leniter constrictae, $35-40 \times 16-18 \mu\text{m}$.

Colonies amphigenous, thin to subdense, up to 3 mm in diam., rarely confluent. Hyphae straight to flexuous, branching opposite to irregular at acute to wide angles, loosely reticulate, cells $12-18 \times 6-7 \mu\text{m}$. Hyphopodia alternate, straight to curved, slightly distantly placed, antrorse, subantrorse to retrorse, $22-24 \mu\text{m}$ long; stalk cells cylindrical to cuneate, $7-9 \mu\text{m}$ long; head cells ovate to globose, entire to angular, truncate, rarely slightly lobate, $14-16 \times 9.5-14.5 \mu\text{m}$. Phialides moderately numerous, mixed with hyphopodia, alternate to opposite, ampulliform, $14-18 \times 6-7 \mu\text{m}$. Perithecia scattered, up to $140 \mu\text{m}$ in diam.; perithecial cells conoid, up to $12 \mu\text{m}$ long; ascospores cylindrical to ellipsoidal, 4-septate, slightly constricted at the septa, $35-40 \times 16-18 \mu\text{m}$.

Holotype: On leaves of *Schumannianthus virgatus* (Roxb.) Rolfe (Marantaceae), Kombe, Neyyar wildlife sanctuary, Thiruvananthapuram, Kerala, India, February 19, 1997, V.B. Hosagoudar TBGT 165. *Isotype*: ILLS 53992.

Etym.: Named for the generic name of the host.

This is the first report of the genus *Asteridiella* on members of the host family Marantaceae (Hansford, 1961; Hosagoudar *et al.*, 1997).



1. *Asteridiella schumannianthi* sp. nov. Hy = Hyphopodia, Pc = Perithecial cells, Ph = Phialides, Sp = Ascospores.

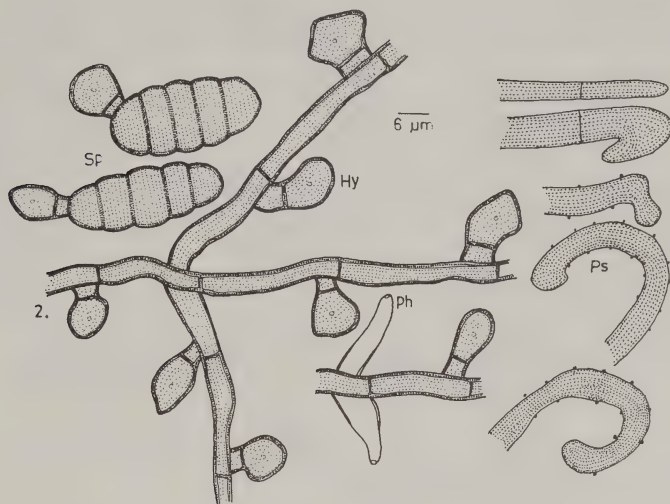
2. *Irenopsis crotonis* (Stev. & Tehon) Stev., Ann. Mycol. 25: 441, 1927; Hansford, Sydowia Beih. 2: 207, 1961.

Irene crotonis Stev. & Tehon, Mycologia 18: 20, 1926. (Fig. 2)

Colonies epiphyllous, thin, spreading, covering entire upper surface of the leaves. Hyphae substraight to undulate, branching opposite to irregular at acute to wide angles, loosely reticulate, cells $30-35 \times 4-6 \mu\text{m}$. Hyphopodia alternate, antrorse to subantrorse, $15-20 \mu\text{m}$ long; stalk cells cylindrical to cuneate, $5-7.5 \mu\text{m}$ long; head cells ovate to globose, mostly entire, often angular to slightly lobate, $10-12.5 \times 9-11.5 \mu\text{m}$. Phialides mixed with hyphopodia, alternate to opposite, ampulliform, $17-20 \times 6-8 \mu\text{m}$. Perithecia scattered to loosely grouped, verrucose, up to $140 \mu\text{m}$ in diam.; perithecial setae 0-9 in numbers, simple, straight at the base, straight to flexuous, irregularly curved to uncinate at the apical part, smooth to coarsely asperate at the upper part, mostly entire, rarely 2-3 septate at the apical part, obtuse at the tip, up to $150 \mu\text{m}$ long; ascospores oblong to cylindrical, 4-septate, constricted at the septa, $32-35 \times 12-15 \mu\text{m}$.

On leaves of *Mallotus repandus* (Willd.) Muell.-Arg. (Euphorbiaceae), Kombe, Neyyar wildlife sanctuary, Thiruvananthapuram, Kerala, India, February 20, 1997, V.B. Hosagoudar TBGT 161. ILLS 53993.

This species was known on *Croton* spp., from Trinidad and New South Wales and is reported here for the first time from India on a hitherto unrecorded host (Hansford, 1961; Hosagoudar, 1996).



2. *Irenopsis crotonis* (Stev. & Tehon) Stev. Hy = Hyphopodia, Ph = Phialides, Ps = Perithecial setae, Sp = Ascospores.

3. *Irenopsis molleriana* (Wint.) Stev., Ann. Mycol. 25: 437, 1927; Hansford, Sydowia Beih. 2: 184, 1961.

Meliola molleriana Wint., Hedwigia 25: 98, 1886.

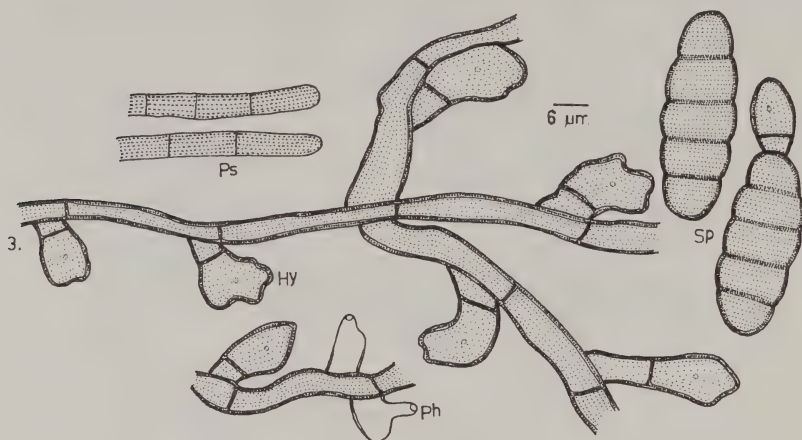
Meliola (Irenina) procera Cif., Ann. Mycol. 36: 219, 1938. (Fig. 3)

Colonies epiphyllous, dense, crustose, up to 1 mm in diam., rarely confluent. Hyphae substraight to flexuous, branching mostly opposite at acute to wide angles, loosely reticulate, cells $24-34 \times 6-7 \mu\text{m}$. Hyphopodia alternate, antrorse to subantrorse, $16-26 \mu\text{m}$ long; stalk cells cylindrical to cuneate, $4.5-14.5 \mu\text{m}$ long; head cells ovate to globose, entire to angular to rarely sublobate, $11-12 \times 9.5-16 \mu\text{m}$. Phialides mixed with hyphopodia, alternate to opposite, ampulliform, $16-20 \times 6.5-8 \mu\text{m}$. Perithecia scattered to loosely grouped up to $150 \mu\text{m}$ in diam.; perithecial setae 0-8, simple, straight, septate, smooth, obtuse at the tip, up to $72 \mu\text{m}$ long; ascospores cylindrical, 4-septate, slightly constricted at the septa, $35-39 \times 14-17.5 \mu\text{m}$.

On leaves of *Hibiscus hispidissimus* Griffith (Malvaceae), Kombe, Neyyar wildlife sanctuary, Thiruvananthapuram, Kerala, India, February 20, 1997, V.B. Hosagoudar TBGT 162. ILLS 53994.

The present collection shows a slight variation from the type of the species in having longer hyphopodia and shorter ascospores. Kapoor (1967) wrongly assigned the *Irenopsis* species parasitic on *Triumfetta bartramia* to this

taxon (Hosagoudar, 1996). In fact, this species is reported here for the first time from India on a hitherto unrecorded host species.



3. *Irenopsis molleriana* (Wint.) Stev. Hy = Hyphopodia, Ph = Phialides, Ps = Perithecial setae, Sp = Ascospores.

4. *Meliola frutescentis* sp. nov.

(Fig. 4)

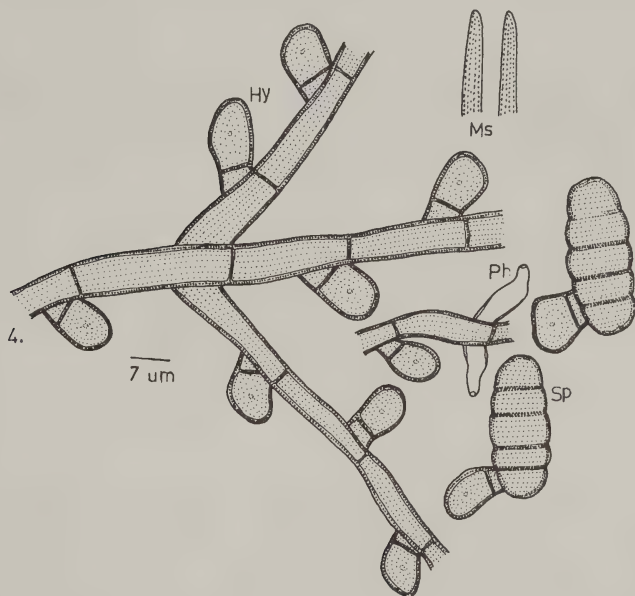
Coloniae epiphyllae, raro amphigenae, densae, velutinae, ad 5 mm diam., confluentes. Hyphae rectae vel flexuosae, plerumque opposite acuteque ramosae, laxae vel raro arte reticulatae, cellulae $24-32 \times 4-6 \mu\text{m}$. Hyphopodia alternata, arte antrorsa vel subantrorsa, $12-18 \mu\text{m}$ longa; cellula basali cylindracea vel cuneata, $4-6.5 \mu\text{m}$ longa; cellula apicali ovata vel globosa, integra, $8-11 \times 8-9.5 \mu\text{m}$. Phialides mixtus cum hyphopodia, alternata vel opposita, ampullacea, $14-18 \times 4-6.5 \mu\text{m}$. Setae myceliales circum perithecia aggregatae, simplices, retae, acutae vel subacutae ad apicem, ad $835 \mu\text{m}$ longae. Perithecia dispersa, verrucosa, ad $130 \mu\text{m}$ diam.; ascospores obovoideae vel cylindraceae, 4-septatae, constrictae, $28-32 \times 11-13 \mu\text{m}$.

Colonies epiphyllous, rarely amphigenous, dense, velvety, up to 5 mm in diam., confluent. Hyphae straight to flexuous, branching mostly opposite at acute angles, loosely to rarely closely reticulate, cells $24-32 \times 4-6 \mu\text{m}$. Hyphopodia alternate, closely antrorse to subantrorse, $12-18 \mu\text{m}$ long; head cells ovate to globose, entire, $8-11 \times 8-9.5 \mu\text{m}$. Phialides mixed with hyphopodia, alternate to opposite, ampulliform, $14-18 \times 4-6.5 \mu\text{m}$. Mycelial setae mostly grouped around perithecia, simple, straight, acute to subacute at the tip, up to $835 \mu\text{m}$ long. Perithecia scattered, up to $130 \mu\text{m}$ in diam.; ascospores obovoid to cylindrical, 4-septate, constricted at the septa, $28-32 \times 11-13 \mu\text{m}$.

Holotype: On leaves of *Ichnocarpus frutescens* (L.) R. Br. (Apocynaceae), Kombe, Neyyar wildlife sanctuary, Thiruvananthapuram, Kerala, India, February 20, 1997, V.B. Hosagoudar TBGT 173. *Isotype*: ILLS 53995.

Etym.: Named for the specific epithet of the host.

This new species is close to *Meliola ichnocarpi* Hansf. & Thirum. known on the same host from southern India but differs from it in having smaller hyphopodia and ascospores (Hansford, 1961; Hosagoudar, 1996).



4. *Meliola frutescentis* sp. nov. Hy = Hyphopodia, Ms = Mycelial setae, Ph = Phialides, Sp = Ascospores.

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MOLECULAR RELATIONSHIPS WITHIN THE GENUS
AMYLOSTEREUM AS DETERMINED BY INTERNAL
TRANSCRIBED SPACER SEQUENCES OF THE RIBOSOMAL
DNA

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Abstract

Intraspecific and interspecific variation in ITS sequences of ribosomal DNA was studied among different genets (clonal lines) of *Amylostereum areolatum*, *A. chailletii* and *A. laevigatum*. No intraspecific variation was found within *A. chailletii* and *A. laevigatum* isolates. The sequences of *A. areolatum* isolates from Denmark and Sweden were also identical, but differed from Lithuanian strain by a single base. High sequence homology (> 97 %) was revealed among the three species from the genus *Amylostereum*. Results of the study indicated a closer relationship between *A. chailletii* and *A. laevigatum*, than between the latter two species and *A. areolatum*.

Introduction

In Europe, the basidiomycete genus *Amylostereum* Boid. (family *Stereaceae* Pilat) consists of three species, *A. areolatum* (Fr.) Boid., *A. chailletii* (Pers.: Fr.) Boid., and *A. laevigatum* (Fr.) Boid., which inhabit wood of various conifer trees (Eriksson & Ryvarden, 1973; Eriksson *et al.*, 1978; Jahn, 1979; Breitenbach & Kränzlin, 1986). All three species are completely intersterile and produce basidiospores that possess tetrapolar outcrossing mating systems (Boidin & Lanquetin, 1984). Besides spread by airborne basidiospores, *A. areolatum* and *A. chailletii* are additionally distributed by siricid woodwasps as oidia or arthrospores (vegetative mycelium) (Stillwell, 1966; Coutts & Dolezal, 1969; Kobayashi *et al.*, 1978; Thomsen & Koch, 1993, 1999; Thomsen, 1996).

In nature, fungal spread by vegetative propagules may result in formation of vegetative compatibility groups (VCGs) that are genetically isolated from each other and consist of spatially separated isolates (Anderson & Kohn, 1995). In fact, VCGs of *A. areolatum* (carried by *Sirex juvencus* L.) and *A. chailletii* (carried by *Urocerus gigas* L.) have already been detected in northern Europe (Thomsen, 1996; Thomsen

& Koch, 1999; Vasiliauskas & Stenlid, 1999). Furthermore, DNA fingerprinting has shown that those VCGs correspond to clonal lineages, which may remain stable over space and time (Vasiliauskas *et al.*, 1998).

The internal transcribed spacer (ITS) region of the ribosomal DNA (rDNA) is reported to exhibit a high degree of polymorphism between species, but to be highly conserved within species, thus providing information on the molecular relationships between fungal taxonomic units (Bruns *et al.*, 1991; Gardes *et al.*, 1991). A number of morphological differences between *A. areolatum* and *A. chailletii* have already been reported (Thomsen, 1998). The aim of the present study was, by means of ITS sequence analyses, to study relatedness between the three *Amylostereum* species and to check for possible within species variation among different genets (clonal lines) of *A. areolatum*, *A. chailletii* and *A. laevigatum*.

Materials and methods

The isolates used in this study are listed in Table 1. Each of them was already found to be genetically distinct from each other, and the isolates of *A. areolatum* and *A. chailletii* were the representatives from different clonal lineages (Thomsen, 1996; Vasiliauskas *et al.*, 1998; Thomsen & Koch, 1999; Vasiliauskas & Stenlid, 1999, unpublished data). Subcultured mycelia were maintained in pure culture on Hagem agar medium at 4 °C. Mycelia for DNA extraction were grown for two weeks on liquid Hagem medium in static cultures at room temperature.

Table 1. List of *Amylostereum* spp. isolates used in this study.

Species	Isolate	Geographic origin	Host	Collector, year
<i>A. areolatum</i>	DK-540	Denmark	<i>Sirex juvencus</i>	I.M. Thomsen, 1994
<i>A. areolatum</i>	S3-25	Sweden	<i>Picea abies</i>	J. Stenlid, 1993
<i>A. areolatum</i>	LI-9	Lithuania	<i>Picea abies</i>	R. Vasiliauskas, 1994
<i>A. chailletii</i>	BC-623	Scotland	<i>Picea sitchensis</i>	D. Redfern, 1981
<i>A. chailletii</i>	S1-22	Sweden	<i>Picea abies</i>	J. Stenlid, 1993
<i>A. chailletii</i>	LI-116	Lithuania	<i>Picea abies</i>	R. Vasiliauskas, 1994
<i>A. laevigatum</i>	BL-84	England	<i>Thuja plicata</i>	B. Greig, 1982
<i>A. laevigatum</i>	BL-174	England	<i>Thuja plicata</i>	B. Greig, 1980
<i>A. laevigatum</i>	BL-278	England	<i>Thuja occidentalis</i>	B. Greig, 1979

DNA from the isolates was obtained during earlier studies (Vasiliauskas *et al.*, 1998). PCR amplifications and DNA sequencing procedures followed the study of Kåren *et al.* (1997). PCR amplifications were performed with a Perkin-Elmer Cetus DNA thermal cycler (model GenAmp 2400). The primer pair ITS1/ITS4 was used to amplify the ITS region (White *et al.*, 1990). Reaction components for the PCR were: 0.01-1.0 ng/μl of total DNA, 0.1 μM of each primer, 0.025 U/μl of Taq-polymerase, 200 μM dNTP, 10 mM Tris-HCl, 1.5-3.0 mM MgCl₂ and 5 μM KCl. Cycling parameters were an initial denaturation at 95 °C for 3 min, followed by 35 cycles of denaturation at 95 °C for 2 min, annealing at 53 °C for 22 s, and extension at 72 °C for 1 min, with a final extension at 72 °C for 10 min. Negative controls, without DNA

template, were prepared in every series of amplification in order to exclude the possibility of contamination. Electrophoresis of PCR products was carried out on a 1.0 % agarose gel (LE-agarose, FMC BioProducts, Rockland, USA). Each PCR product was cleaned using the QIAquick PCR purification kit (QIAGEN Inc., Chatsworth, USA).

Sequences were determined with an Applied Biosystems (Foster City, CA, USA) 310 sequencer with the *Taq* DyeDeoxi Terminator™ cycle system (Perkin Elmer), using each of the primers ITS1, ITS2 and ITS3 (White *et al.*, 1990). The alignment of the sequences was performed manually. The whole procedure of ITS amplification and sequencing was performed twice for all isolates with identical results.

Results

A single product of uniform size resulted from all PCR amplifications, corresponding to approx. 600 bp in size (data not shown). There was no intraspecific variation in the ITS region of studied *A. chailletii* and *A. laevigatum* isolates. ITS sequences of *A. areolatum* isolates from Denmark and Sweden were also identical, but differed from Lithuanian strain by a single base (A → G) at 279 bp position.

Aligned sequences of the ITS region of all three species are presented in Fig. 1. In general, high sequence homology (> 97 %) was revealed among the three *Amylostereum* species. Thus, similarity in the ITS region between *A. chailletii* and *A. laevigatum* was 98.8 % (7 variable sites), between *A. chailletii* and *A. areolatum* 97.2 % (16 variable sites), and between *A. laevigatum* and *A. areolatum* 97.4 % (15 variable sites). However, when proportion of similar sites between *A. chailletii* and *A. laevigatum* was compared by χ^2 -test with that between *A. chailletii* and *A. areolatum*, the difference was statistically insignificant ($\chi^2 = 3.80$, $p > 0.05$). Therefore the area sequenced was too similar to resolve clearly the question of the relationships between the three species. Despite that it indicated that *A. chailletii* and *A. laevigatum* might be more closely related than *A. chailletii* and *A. areolatum*.

Discussion

In the present study, identical intraspecific ITS sequences of rDNA are reported for *A. chailletii* and *A. laevigatum*. Nearly identical intraspecific sequences were found in *A. areolatum* (within species variation was at one nucleotide site). Except for *A. laevigatum*, isolates of the species studied were collected within rather large geographical scale (Table 1) and were separated in nature by ca. 800 km and open seas. In addition, examined strains of *A. areolatum* and *A. chailletii* represented clonal lineages that are genetically isolated within each species (Vasiliauskas *et al.*, 1998).

In other studies, no intraspecific variation was found in the ITS region among isolates from ectomycorrhizal basidiomycetes *Cortinarius armillatus* (collected ca. 350 km apart) and *C. traganus* (collected ca. 650 km apart) (Kåren *et al.*, 1997). In *Suillus luteus*, only one base difference was detected even between isolates originating from Europe and North America (Kretzer *et al.*, 1996).

Fig. 1. Aligned sequences of the ITS region of *Amylostereum areolatum* (A.A.), *A. chailletii* (A.C.), and *A. laevigatum* (A.L.). Site differences within the genus *Amylostereum* are underlined. Site change within the species *A. areolatum* (279 bp) indicated by arrow.

Despite a wide geographical range of collected strains, interspecific variation within the genus *Amylostereum* (among the three species studied) was very low, especially if compared with ITS sequence variation observed in other basidiomycete macrofungi. Thus, it approximated to intraspecific variation reported within certain species of *Lentinus* (Hibbet & Vilgalys, 1993), *Cantharellus* and *Craterellus* (Feibelman *et al.*, 1997), *Pisolithus* (Anderson *et al.*, 1998), and European *Armillaria* (Chillali *et al.*, 1998). Rather similar level of ITS sequence variation was noted also among intersterile groups (biological species) within complexes of *Heterobasidion* (Kasuga *et al.*, 1993; Kasuga & Mitchelson, 1993), and that of North American *Armillaria* (Anderson & Stasovski, 1992).

The present study showed that more similarity in ITS nucleotide sequence exists between *A. chailletii* and *A. laevigatum*, than between *A. chailletii* and *A. areolatum*. This was unexpected for several reasons. First, both *A. chailletii* and *A. areolatum* in Europe commonly occur on wood of the same host, e.g. spruce (*Picea*) (Eriksson & Ryvarden, 1973; Eriksson *et al.*, 1978; Breitenbach & Kränzlin, 1986). In contrast, *A. laevigatum* has a very distinctive host range and grows only on wood of *Juniperus*, *Taxus* and *Thuja* (Eriksson & Ryvarden, 1973; Jahn, 1979; Breitenbach & Kränzlin, 1986). Second, decay patterns in spruce of both *A. chailletii* and *A. areolatum* are very similar (Vasiliauskas, 1999). Third, both *A. chailletii* and *A. areolatum* are symbiotic with siricid woodwasps, whereas *A. laevigatum* is not (Talbot, 1977). In insect-associated ascomycetes, for example, related taxonomic lineages were thought to diverge depending on association with different beetle species (Blackwell & Jones, 1997).

Some evidence is available to suggest that *A. chailletii* and *A. laevigatum* are more closely related to each other than to *A. areolatum*. Thus Boidin & Lanquetin (1984) proposed to expand the genus *Amylostereum* and to include the tropical species, *A. ferreum* Berk. et Curt. Mating tests had shown that *A. ferreum* was partially fertile both with *A. chailletii* and with *A. laevigatum*, but was completely intersterile with *A. areolatum* (Boidin & Lanquetin, 1984). In the recent study, mitochondrial small subunit rDNA and the intergenic spacer region of the nuclear rDNA of *Amylostereum* species were sequenced, and it was found that *A. laevigatum* and *A. ferreum* are phylogenetically more closely related to *A. chailletii* than to *A. areolatum* (Slippers *et al.*, 1998).

A. laevigatum in Europe was suspected to contain two different taxa - one occurring on *Juniperus* and possessing shorter basidiospores, and another occurring on *Taxus* and *Thuja* with the longer basidiospores (Eriksson & Ryvarden, 1973; Hallenberg & Hallingbäck, 1974). Despite the fact that both forms appeared to be completely

	10	20	30	40	50
A.A.	GATCATTATC	GAATTCAGAA	CGCTTGGGTT	GTAGCTGGTC	TTTCAGGGAC
A.C.	GATCATTATC	GAATTCAGAA	CGCTTGGGTT	GTAGCTGGTC	CCTC-GGGAC
A.L.	GATCATTATC	GAATTCAGAA	CGCTTGGGTT	GTAGCTGGTC	<u>CCT-AGGGAC</u>
	60	70	80	90	100
A.A.	AAGTGCTCGC	CCTTGCTCTT	TCCGACACAC	CCTGTGCACT	CCCGCGTGGG
A.C.	AAGTGCTCGC	CCTTGCTCTT	TCCGACACAC	CCTGTGCACT	CCCGCGTGGG
A.L.	AAGTGCTCGC	<u>CCTCGCTCTT</u>	TCCGACACAC	CCTGTGCACT	CCCGCGTGGG
	110	120	130	140	150
A.A.	CTGCGGTGAC	TTCGGTTGCC	GTGCCCGCGA	TTTTATACAC	TCTTTGTATG
A.C.	CTGCGATGAC	CTCGGTCGTC	GCGCTCGCGA	TTTTATACAC	TCTTCGTATG
A.L.	CTGCGATGAC	<u>TTCGGTTGTC</u>	<u>GCGCTCGCGA</u>	TTTTATACAC	TCTTCGTATG
	160	170	180	190	200
A.A.	TCTCAGAATG	TCTTTGCGTG	TTGCGCATCT	AATACAACCT	TCAACAACGG
A.C.	TCTCAGAATG	TCTTTGCGTG	TTGCGCATCT	AATACAACCT	TCAACAACGG
A.L.	TCTCAGAATG	TCTTTGCGTG	TTGCGCATCT	AATACAACCT	TCAACAACGG
	210	220	230	240	250
A.A.	ATCTCTTGGC	TCTCGCATCG	ATGAAGAACG	CAGCGAAATG	CGATAAGTAA
A.C.	ATCTCTTGGC	TCTCGCATCG	ATGAAGAACG	CAGCGAAATG	CGATAAGTAA
A.L.	ATCTCTTGGC	TCTCGCATCG	ATGAAGAACG	CAGCGAAATG	CGATAAGTAA
	260	270	A 280	290	300
A.A.	TGTGAATTGC	AGAATTCAGT	GAATCATCGA	ATCTTTGAAC	GCACCTTGCG
A.C.	TGTGAATTGC	AGAATTCAGT	GAATCATCGA	ATCTTTGAAC	GCACCTTGCG
A.L.	TGTGAATTGC	AGAATTCAGT	GAATCATCGA	ATCTTTGAAC	GCACCTTGCG
	310	320	330	340	350
A.A.	CCCCTTGGTA	TTCCGAGGGG	CACACCTGTT	TGAGTGTCTG	GAATTCTCA
A.C.	CCCCTTGGTA	TTCCGAGGGG	CACACCTGTT	TGAGTGTCTG	GAATTCTCA
A.L.	CCCCTTGGTA	TTCCGAGGGG	CACACCTGTT	TGAGTGTCTG	GAATTCTCA
	360	370	380	390	400
A.A.	ACTCCGCCTC	CTTTGCGGGA	GCGCGGGGCT	TGGAGTTGGA	GGCTTGCGGG
A.C.	ACTCCGCCTC	CTTTGCGGGA	GAGCGGGGCT	TGGAGTTGGA	GGTTTGCGGG
A.L.	ACTCCGCCTC	CTTTGCGGGA	<u>GCGCGGGGCT</u>	TGGAGTTGGA	<u>GGTTTGCGGG</u>
	410	420	430	440	450
A.A.	CGTAAGTCCG	CTCCTCTCAA	ATGCATTAGT	GAAGCCCAGG	TGGCCTCGGC
A.C.	CGCAAGTCCG	CTCCTCTCAA	ATGCATTAGT	GAAGCCCAGG	TGGCCTCGGC
A.L.	<u>CGCAAGTCCG</u>	CTCCTCTCAA	ATGCATTAGT	GAAGCCCAGG	TGGCCTCGGC
	460	470	480	490	500
A.A.	GTGATAATTG	TCTACGTCCA	AGGTGTGCTG	TAGCGGTTTT	CGCTTCTAAC
A.C.	GTGATAATTG	TCTACGTCCA	AGGTGTGCTA	TGCGGTTTTT	CGCTTCTAAC
A.L.	GTGATAATTG	TCTACGTCCA	AGGTGTGCTA	<u>TGCGGTTTTT</u>	<u>TGCTTCTAAC</u>
	510	520	530	540	550
A.A.	CGTCCCTTCG	GACAATTCAT	CGAAACTTGA	CCTCAGATCA	GGTGGGACTA
A.C.	CGTCCCTTCG	GACAATTCAT	CGAAACTTGA	CCTCAGATCA	GGTGGGACTA
A.L.	<u>CGTCCCTTCG</u>	GACAATTCAT	CGAAACTTGA	CCTCAGATCA	GGTGGGACTA
	560	570	580	590	600
A.A.	CCCCTGAAC	TTAAGCATAT	CAATAAGCGG		
A.C.	CCCCTGAAC	TTAAGCATAT	CAATAAGCGG		
A.L.	CCCCTGAAC	TTAAGCATAT	CAATAAGCGG		

intersterile (Hallenberg & Hallingbäck, 1974), it might be of interest in future studies to consider genetic variation among both types of *A. laevigatum* (in this work only isolates from *Thuja* were included), and also to include strains of *A. ferreum*.

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TWO NEW CORTICOLOUS SPECIES OF THE GENUS *LECIDELLA* (LECANORACEAE, LECANORALES, LICHENIZED ASCOMYCOTINA)

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Abstract: Two new corticolous *Lecidella* species are described: *Lecidella aptrootii* Knoph & Garnitz, collected on the Island of Luzon, Philippines, and *Lecidella commutata* Knoph & Leuckert, which is so far only known from Uruguay and New Zealand.

Introduction

The crustaceous genus *Lecidella* comprises about 40 species occurring on various substrata (including rock, bark, wood etc.). The vast majority of these species inhabits siliceous rock and/or bark, which are usually exposed. The genus is widespread from (ant)arctic to tropical zones. There are several recent papers dealing with its saxicolous taxa (e. g. Hertel, 1977; Poelt & Vězda, 1981; Rambold, 1989; Knoph, 1990; Leuckert et al., 1990, 1992; Knoph & Leuckert, 1994; Knoph et al., 1995a, 1995b) but only a few newer publications on the non-saxicolous ones (e. g. Poelt & Vězda, 1981; Tønsberg, 1992; Knoph et al., 1995b; Knoph & Leuckert, 1997). During the revision of non-saxicolous specimens of the genus, two new species were discovered from the subtropical and the austral zone, respectively, for which descriptions are presented.

Materials and Methods

The specimens analyzed for this study were borrowed from the institutional herbaria of H and S, and the private herbarium of A. Aptroot. The chemistry was examined by means of thin-layer chromatography (TLC) using the standardized methods of Culbertson (1972). Chloroxanthones were detected with a method developed by Leuckert & Knoph (1992). In addition, all samples were studied using lichen mass spectrometry as described in Leuckert et al. (1990). Morphological and anatomical characters were examined with Zeiss binocular microscopes (6,5-50 x, and 32x, 63x, 125x, 250x, 500x, 1000x). Apothecial anatomy was studied in 10-15 μ m thick vertical sections (Leitz freezing microtome) mounted in water or in lactophenol and stained with cotton blue. Tests for amyloid reactions were usually made by mounting sections directly in Lugol's solution (I_{conc}).

Lecidella aptrootii Knoph & Garnitz spec. nova

Diagnosis: Thallus crustaceus, ca. 0.2 mm altus, usque ad 1 cm in diametro, albus, rimosus, sorediis et isidiis destitutus. Apothecia frequentia, dispersa, 0.2 - 0.25 mm (max. 0.33 mm) in diametro, sessilia vel semiimmersa, margine atro, distincto, disco plano, atro, epruinoso. Epihymenium ca. 5 μ m altum, viride vel fuscoatrum. Hymenium incoloratum, 55 - 85 μ m altum. Subhymenium incoloratum. Hypothecium incoloratum, ca. 70 μ m altum. Excipulum 65 - 80 μ m latum, interne incoloratum. Paraphyses ca. 2.0 μ m, apice ad 3.0 μ m in diametro. Asci clavati, ca. 75 x 20 μ m. Tholus amyloideus et massam axialem non amyloideam exhibens. Sporae ellipsoideae, unicellulares, non halonatae, 11 - 15 μ m longae, 6 - 9 μ m latae.

Type: PHILIPPINES, Island of Luzon, Province Benguet: Baguio, Mt. Santa Tomas, coord. 120°35' E, 16°18' N, cloud forest, on branches, alt. 2200 m, February 1987, A. Aptroot 20484 (hb. Aptroot, holotype).

Description: Thallus coherent to rimose, up to 1.0 cm diameter, up to c. 0.2 mm thick, white to yellow-white (partly grey-brownish due to damage?), with rough surface. Algal cells ca. 10 μ m, max. 13 μ m diameter. Medulla I- (at some parts I+), hyphae c. 3 - 4 μ m thick. Hypothallus rarely developed at the thallus margin, black, up to 0.1 mm thick. Apothecia irregular to round, dispersed to dense, partly immersed into the thallus or sessile, more or less constricted at the base, c. 0.20 - 0.25 mm, max. 0.33 mm diameter. Disc plane, not becoming convex, slightly nitid, epruinose. Margin distinct from

the beginning, black, slightly nitid. Excipulum max. 80 μm , aside of hymenium 65 - 75 μm thick. Ectal zone c. 5 μm , colorless to weakly (greenish to blackish) brown, hyphae c. 5 - 6 μm diameter, with lumina of c. 1.5 μm . Inner zone colorless, hyphae c. 3 (- 4) μm diameter, with lumina of c. 1.5 μm . Medullary zone not obvious. Hypothecium colorless, up to 70 μm thick, hyphae c. 5 - 6 μm diameter, subhymenial layer colorless, c. 15 - 20 μm thick, hymenium c. 55 - 85 μm thick, colorless, inspersed, $I \pm$ blue, I_{conc}^- . Epihymenium pale greenish to blackish brown, c. 5 μm thick. Paraphyses rarely branched and anastomosing, c. 2 μm , apical cells c. 3 μm diameter. Asci c. 75 x 20 μm . Tholus max. 6 μm thick, outer amyloid wall layer c. 1.0 - 1.5 μm , non-amyloid wall layer c. 0.5 μm thick. Spores ellipsoid, 11 - 15 x 6 - 9 μm . Pycnidia not observed.

Chemistry: One chemotype observed: containing atranorin, aotearone, 2,5,7-trichloro-3-*O*-methylnorlichexanthone (major compounds), 3-*O*-methylasezone (trace), isoarthothelin (may be trace in one specimen) (2 specimens examined).

Ecology and distribution: *Lecidella aptrootii* is so far only known from Mt. Santa Tomas, Philippines. It was found in cloud forest on branches and twigs.

Lichenicolous fungi: not observed.

Discussion: *Lecidella aptrootii* is characterized by small, partly immersed or sessile apothecia, a colorless hypothecium and the presence of atranorin along with several xanthenes. *Lecidella elaeochroma* can be distinguished by a usually brown hypothecium and broader apothecia.

Additional specimens examined: Island of Luzon, Province Benguet: Baguio, Mt. Santa Tomas, coord. 120°35' E, 16°18' N, cloud forest, on branches, alt. 2200 m, February 1987, A. Aptroot 20485 (hb. Aptroot).

Lecidella commutata Knoph & Leuckert spec. nova

Diagnosis: Thallus crustaceus, 0.5 mm altus, usque ad 1.5 cm in diametro, rimosus vel areolatus, sorediis et isidiis destitutus. Areolae irregulares vel rotundae. Apothecia frequentia, dispersa vel crebra, 0.2 - 0.4 mm (max. 0.5 mm) in diametro, sessilia, margine atro, distincto, disco plano vel subconvexo, atro, epurinoso. Epihymenium ca. 5 μm altum, incoloratum vel oliva-

ceum. Hymenium incoloratum, 50 - 95 μm altum. Subhymenium incoloratum. Hypothecium incoloratum, ca. 250 μm altum. Excipulum ca. 50 - 65 μm latum, interne incoloratum. Paraphyses ca. 1.5 - 2 μm , apice ad 5.0 μm in diametro. Asci clavati, ca. 55 x 18 μm . Tholus amyloideus et massam axialem non amyloideam exhibens. Sporae ellipsoideae, unicellulares, non halonatae, 5.5 - 12.5 μm longae, 4.5 - 7.5 μm latae.

Type: NEW ZEALAND, North Island: Wellington, 1874 - 75, S. Berggren (S, holotype).

Description: Thallus coherent to areolate, up to 1.5 cm diameter, up to 0.5 mm thick. Areoles (irregularly shaped to) mostly roundish, white to yellow-white, with rough surface, c. 0.05 - 0.15 mm, max. up to 0.2 mm diameter. Algal cells c. 10 - 12 μm , max. 15 μm diameter. Medulla I-, hyphae c. 4 μm thick. Hypothallus rarely developed at the thallus margin or between the areoles, black. Apothecia (irregular to) round, dispersed to crowded, more or less constricted at the base, c. 0.2 - 0.4 mm, max. 0.5 mm diameter. Disc plane, rarely becoming moderately convex, black, matt to nitid, epruinose. Margin distinct from the beginning, commonly not evident in the more convex apothecia, black, nitid. Excipulum max. 65 μm , aside of hymenium c. 50 μm thick. Ectal zone c. 5 μm , colorless to pale yellowish olive-grey, hyphae c. 6 - 9 μm diameter. Inner zone colorless, hyphae c. 3 - 4 μm diameter, with lumina of c. 1.5 μm . Medullary zone not obvious. Hypothecium colorless, up to 250 μm thick, hyphae c. 4 μm diameter, subhymenial layer colorless, c. 25 μm thick, hymenium c. 50 - 95 μm thick, colorless, I+ blue, I_{conc}-. Epihymenium colorless to pale yellowish olive-grey, c. 5 μm thick. Paraphyses sometimes branched and anastomosing, c. 1.5 - 2.0 μm , apical cells c. 4.0 - 5.0 μm diameter. Asci c. 55 x 18 μm . Tholus max. 8.0 μm thick, outer amyloid wall layer c. 1.0 μm , non-amyloid wall layer c. 0.5 μm thick. Spores ellipsoid, 7.5 - 12.5 x 4.5 - 7.5 μm . Pycnidia not observed.

Chemistry: Two chemotypes observed: a) containing vicanicin (major compound); vicanicinmonomethylether (trace) (specimen from Uruguay), b) containing vicanicin (major compound); 2,5,7-trichloro-3-O-methylnorlichexanthone (trace) (specimens from New Zealand).

Ecology and distribution: *Lecidella commutata* is so far only known from Uruguay (growing on bark) and New Zealand (growing on wood).

Lichenicolous fungi: not observed.

Discussion: *Lecidella commutata* is characterized by small apothecia, a colorless hypothecium and the presence of vicanicin as a major compound along with sometimes a trace of 2,5,7-trichloro-3-*O*-methylnorliche-xanthone. A similar chemistry has *Lecidella sublapicida* but this species can be distinguished by a brown hypothecium.

Additional specimens examined: URUGUAY, Rocha: Rocha, in ripar, humid. umbr., 10 - 50 m, August 1928, W. G. F. Herter 83680 (H). - NEW ZEALAND, North Island: Wellington, Juli 1874, S. Berggren (S).

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STUDIES ON MAZAEDIATE LICHENS AND CALICIOID FUNGI OF THE IBERIAN PENINSULA

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Abstract: 49 species of mazaediate lichens and calicioid fungi are reported from the Iberian Peninsula. *Cyphelium notaristii* and *Thelomma siliceum* are new to Spain, *Chaenotheca phaeocephala*, *Chaenothecopsis debilis*, *Ch. hospitans* and *Ch. pusiola* are new to the Iberian Peninsula. Many species are new records for several provinces. A short description together with ecological and distributional data is provided for each taxon.

INTRODUCTION

Lichens and fungi previously referred to Caliciales (Ascomycota) are polyphyletic (WEDIN & TIBELL 1997). They include 26 genera in 8 families, and most of the species have a mazaedium and passive spore dispersal. The ascospore ontogeny is extremely diverse. Mazaediate lichens and calicioid fungi occur on all continents but most of them are found in cool to warm temperate areas (TIBELL 1996).

These lichens and fungi are fairly well-known in central and northern Europe (TIBELL 1971, 1976, 1980; TIBELL & RYMAN 1995), but there is little information from Southwest Europe. The papers by BENTO-PEREIRA (1981) and HLADÚN (1984) are the only monographic treatments of this group on the Iberian Peninsula, and this lack of information encouraged us to study the calicioid fungi and mazaediate lichens in this area.

A tentative biogeographical analysis of 49 species included in 10 different genera is presented. Some species are new for the Iberian Peninsula, and many species represent considerable southern extensions of their European distributions.

MATERIAL AND METHODS

The present study is based on 350 specimens of fresh material and a revision of herbaria (COI, GZU, LISU, MA, MACB, MAF). The species were determined by their morphological and chemical characters, and a short description is given on several of them. An analysis of secondary lichen products was made in the genus *Sphaerophorus* and was performed from acetone extracts by thin layer chromatography (TLC) according to a standardized procedure (WHITE & JAMES 1985). The species distribution maps are based only on the specimens studied.

RESULTS

Calicium Pers.

Ann. Bot. (Usteri) 7: 20 (1794)

1. *Calicium abietinum* Pers.

Tent. Disp. Meth. Fung. Suppl.: 59 (1797)

Thallus immersed. Apothecia epruinose, stalk with hyaline envelope. Asci cylindrical, 44-60 μm . Ascospores 11-15.4 x 6-8.8 μm , broadly ellipsoid, with minute warted ornamentation.

C. abietinum is widespread and common on the Iberian Peninsula. It is most frequent in the Mediterranean Region, especially in the meso- and supramediterranean belts. It grows on lignum of deciduous trees, usually *Castanea sativa*, *Fraxinus angustifolia*, *Quercus pyrenaica* and *Q. faginea*, rarely on bark of conifers (only collected on *Pinus nigra* in the south) and wooden poles. Its altitudinal range is from 550 to 1500 m.

Material studied (Fig. 1): SPAIN: **Albacete**: Bienservida, sierra de Alcaraz, Aragón *et al.*, 25-IV-1997, MA 9260. Paterna del Madera, sierra de Alcaraz, Aragón & Martínez, 12-IV-1997, MA 9259. **Asturias**: Muniellos, Equipo, 1-IX-1980, MAF 1666. **Cáceres**: Villar del Pedroso, Aragón & Martínez, 4-I-1995, MA 7716. **Ciudad Real**: Fuencaliente, Garganta de los Pozuelos, Sarrión & López, 14-II-1996, Herb. Sarrión 159, 171. Fuencaliente, Umbria de Dormideros, Sarrión, 3-I-1991, Herb. Sarrión 32. Solana del Pino, Sarrión, 10-XII-1995, Herb. Sarrión 117. Viso del Marqués, arroyo de Ruimula, Sarrión, 13-VIII-1992, Herb. Sarrión 31. "Ibidem", El Robledillo, 7-X-1992, Herb. Sarrión 128. **Cuenca**: Buenache de la Sierra, Serranía de Cuenca, Aragón & Martínez 2560, 7-III-1998, MA. **Jaén**: Segura de la Sierra, sierra de Segura, Aragón & Martínez, 15-V-1995, Herb. Aragón. Andújar, sierra de Quintana, Sarrión, 17-I-1996, Herb. Sarrión 39. **Orense**: Montes do Invernadeiro, Villarino de Conso, Martínez & Burgaz, 19-VI-1995, Herb. Sarrión 134, 136. **Toledo**: Hontanar, Montes de Toledo, Aragón *et al.*, 10-VI-1995, MA 7724. Los Navalucillos, Montes de Toledo, Aragón *et al.*, 2-IV-1995, MA 7709. San Pablo de los Montes, Montes de Toledo, Aragón & Martínez, 5-I-1995, MA 7148. **Zamora**: Cobrerros, Lago de Sanabria, Aragón *et al.*, 6-IX-1996, MA 8794. Galende, Lago de Sanabria, Aragón *et al.*, 7-IX-1996, MA 8841. Trefacio, Lago de Sanabria, Aragón *et al.*, 28-IX-1996, MA 8939.

2. *Calicium adpersum* Pers.

Icon. Descr. Fung. 2: 59 (1800)

Thallus granular, greyish. Apothecia 0.6-1 mm tall, with yellow pruina on the capitulum. Asci clavate when mature. Ascospores $11-15 \times 6 \mu\text{m}$, with ornamentation consisting of spirally arranged ridges. Thallus Pd + yellow to red, K+ red, C-.

This is a very rare species in Spain, collected only in the south. Nevertheless, it is locally abundant on rough bark of *Abies pinsapo* in exceptionally warm, very humid and shaded situations at 1200-1400 m in the supramediterranean belt.

Material studied (Fig. 2): SPAIN: **Málaga**: Ronda, sierra de las Nieves, *Aragón & Martínez*, 18-III-1995, MA 7715. Ronda, Cañada del Cuerno, *Etayo et al.*, 16-IV-1994, MA 5709.

3. *Calicium corynellum* (Ach.) Ach.

Meth. Lich.: 94 (1803)

Parasymbiont or parasite. Apothecia short stalked, with whitish (sometimes yellowish) pruina on the capitulum. Asci subclavate $25-30 \times 3.5-5.5 \mu\text{m}$. Ascospores $10-13.2 \times 4.4-6.6 \mu\text{m}$, blackish, with ornamentation of spirally arranged ridges to coarsely and irregularly cracked-areolate when mature. Sometimes it grows together with *Chaenothecopsis hospitans*.

C. corynellum has a scattered distribution in the Mediterranean Region (meso- and supramediterranean belts), being most frequent in central mountains, in humid and shaded situations. It grows in fissures of siliceous rocks (granitic, quartzitic and slaty) from 650 to 1600 m.

Material studied (Fig. 3): PORTUGAL: **Tras-os-Montes**: Moncorvo, *Sampaio*, 14-X-1916, Porto 1147, COI. SPAIN: **Ciudad Real**: Viso del Marqués, *Sarrión*, 9-XII-1994, Herb. Sarrión 25. "Ibidem", *Sarrión*, 6-X-1994, Herb. Sarrión 24. Arroba de los Montes, *Sarrión*, 29-6-1997, Herb. Sarrión 1081; Fuencaliente, *Sarrión et al.*, 5-2-1997, Herb. Sarrión 496. Solana del Pino, *Sarrión et al.*, 4-II-1997, Herb. Sarrión 599. **Madrid**: Canencia, puerto de Canencia, 1300 m, 563 *Rico*, 29-V-1986, MAF. Robledo de Chavela, 828/1 *Rico*, 23-XI-1986, MAF. **Sevilla**: Almadén de la Plata, *Rowe & Hafellner* n° 10402, 5-IV-1982, GZU. **Teruel**: Orihuela del Tremedal, sierra de Albarracín, *Aragón et al.*, 19-V-1996, MA 7730. **Toledo**: Hontanar-Los Navalucillos, *Sarrión*, 19-IX-1996, Herb. Sarrión 293.

4. *Calicium denigratum* (Vain.) Tibell

Bot. Notiser 129: 132 (1976)

This species differs from *C. glauccellum* and *C. abietinum* by the epruinose, longer and more flexuose apothecia, stalk with a thinner hyaline envelope and the coarse and irregularly areolate ascospore ornamentation. Ascospores 11-14

x 6-8 μm . The ratio length/width of apothecia together with the ascospore size are good diagnostic characters as TIBELL (1976) pointed out.

A rather poorly known species in Spain, collected by ETAYO (1989) in the subalpine belt of the Pyrenees, growing on hard lignum of *Pinus uncinata* at 1700 m. *C. denigratum* is only known from the Nordic countries (Norway, Sweden and Finland) and Spain.

Material studied (Fig. 4): SPAIN: **Navarra**: Isaba, Macizo de Añelarra, *Etayo & Diederich*, MA 3724.

5. *Calicium glaucellum* Ach.

Meth. Lich.: 97 (1803)

Thallus immersed. Stalk with hyaline envelope. Capitulum sometimes with a whitish pruina. Asci cylindrical (subclavate when young), 33-45 (50) μm . Ascospores 9-12.5 x 5-7.5 μm , ellipsoid-rhombic, slightly incised at septum, with ornamentation of irregular ridges, areoles and cracks.

A widespread and common species on the Iberian Peninsula but absent from oceanic areas. It was collected in the Mediterranean Region, being distributed in the meso- and supramediterranean belts. In the Eurosiberian Region it is not very abundant, being mainly found in the montane belt. It was collected on lignum of deciduous trees (*Quercus pyrenaica*) and bark of conifers (*Abies* and *Pinus*). It has a wide altitudinal range from 850 to 1650 m.

Material studied (Fig. 5): SPAIN: **Álava**: Cigoitia, Macizo de Gorbea, *Aguirre & Renobales*, 8-IV-1985, MA 3397. **Albacete**: Riópar, Calar del Mundo, *Aragón et al.*, 10-II-1996, MA 7696. Bienservida, sierra de Alcaraz, *Aragón et al.*, 25-IV-1997, MA 9264. Bogarra, sierra de Alcaraz, *Aragón et al.*, 6-X-1996, MA 9262. Paterna del Madera, sierra de Alcaraz, *Aragón & Martínez*, 12-IV-1997, MA 9263. **Asturias**: Parque Nacional de Muniellos, N von Cangas de Narcea, *Hafellner* n° 9811, 9798, 5-IX-1980, GZU. **Ciudad Real**: Fuencaliente, *Sarrión*, 30-VI-1992, Herb. Sarrión 38. "Ibidem", 3-I-1991, Herb. Sarrión 36. "Ibidem", 29-VI-1992, Herb. Sarrión 37. "Ibidem", 1-V-1990, MACB 43895. Fuencaliente, Garganta de los Pozuelos, *Sarrión & López*, 14-II-96, Herb. Sarrión 164, 167. Solana del Pino, *Sarrión*, 26-VI-1993, Herb. Sarrión 122. Viso del Marqués, *Sarrión*, 13-VIII-1992, Herb. Sarrión 33. **Huesca**: Barranco de Santa Elena, *Etayo & Gómez Bolea*, 5-VIII-1993, MA 4215. Biescas, *Sarrión*, 9-IX-1995, Herb. Sarrión 133. **Cuenca**: Serranía de Cuenca, *Aragón & Martínez* 2139, 4-I-1998, MA. Buenache de la Sierra, Serranía de Cuenca, *Aragón & Martínez* 2573, 7-III-1998, MA. Serranía de Cuenca, *Aragón & Martínez* 2879, 14-III-1998, MA. **Jaén**: Orcera, sierra de Segura, *Aragón & Martínez*, 2-V-1996, Herb. Aragón. **Navarra**: Isaba, Macizo de Añelarra, *Etayo & Printzen*, 5-VIII-1993, MA 3726. **Segovia**: Riofrío de Riaza, *Aragón & Martínez*, 26-III-1994, MA. **Soria**: Sierra de Urbión, Laguna Negra, *Etayo & Breuss*, 26-VII-1993, MA 4126. **Tarragona**: Sierra de Prades, Monasterio de Poblet, *Hafellner* n° 3666, 23-V-1983, GZU. **Teruel**: Albarracín, sierra de Albarracín, *Sarrión*, 15-V-1991, Herb. Sarrión 34. Tramacastilla, sierra de Albarracín, *Sarrión*, 15-V-1991, Herb. Sarrión 35. Noguerauelas, sierra de Gúdar, *Aragón et al.*, 15-III-1997, MA 9756. **Toledo**: Hontanar, Montes de Toledo, *Aragón et al.*, 10-VI-1995, MA 7713. Los Navalucillos, Montes de Toledo, *Aragón &*

Martínez, 26-III-1995, MA 7712. San Pablo de los Montes, Montes de Toledo, *Aragón & Martínez*, 5-I-1995, MA 7711. **Zamora**: Cobrerros, valle de Sanabria, *Aragón et al.*, 6-IX-1996, MA 8795. "Ibidem", *Aragón & Martínez*, 2-V-1997, MA 9108. Galende, Lago de Sanabria, *Aragón et al.*, 7-IX-1996, MA 8842. "Ibidem", 8-IX-1996, MA 8863.

6. *Calicium hyperelloides* Nyl.

Syn. Lich. 1 (2): 153 (1860)

Thallus crustose, yellowish green, granulose. Capitulum sometimes slightly pruinose. Ascospores 10-12 x 5-6 μm , with irregularly cracked ornamentation. Thallus Pd-, K+ yellowish, C+, KC+ orange.

This is a very rare species with a north-western distribution on the Iberian Peninsula. It grows on bark of deciduous trees in oceanic areas from 200 to 600 m.

Material studied (Fig. 6): PORTUGAL: **Minho**: Ponte do Lima: Estorãos, *Sampaio*, 10-VIII-1915, COI. Baleia, 4-81, *Moller* (Nylander 100), COI. SPAIN: **Pontevedra**: Monte Castro, *Crespí*, MA 1355.

7. *Calicium lenticulare* Ach.

K. Sv. Vetensk.-Akad. Handl. 1816: 262 (1816)

Thallus minutely granular. Apothecia with whitish pruina on the lower side of the capitulum. Stalk black with a reddish tinge. Stalk and excipulum I+ dark blue. Ascospores 10-14 x 7-8 μm with ornamentation of minute warts. Thallus Pd-, K-, C-.

A rarely collected species with a scattered distribution in the Eurosiberian Region, in the colline and montane belts. It grows on bark of deciduous trees in humid or shaded situations at altitudes of 250 m to 1200 m.

Material studied (Fig. 7): SPAIN: **Asturias**: Parque Nacional de Muniellos, Cangas de Narcea, *Hafellner* n° 9775, 5-IX-1980, GZU. **Navarra**: Oronoz-Mugaire, Señorío de Bértiz, *Etayo*, 30-I-1994, MA 5500.

8. *Calicium quercinum* Pers.

Tent. Disp. Meth. Fung. Suppl. : 59 (1797)

Thallus well developed, verrucose, greyish-green. Apothecia with white pruina on the lower side of the capitulum. Asci narrowly clavate to cylindrical. Ascospores with ornamentation of spirally arranged ridges. Thallus Pd+ yellow, K+ yellow to orange.

Only one specimen was studied, on bark of *Quercus petraea* from the Pyrenees at 850 m. There are also some earlier records in literature (COLMEIRO 1889, HLADÚN 1984).

Material studied (Fig. 8): SPAIN: **Navarra:** Lezaún, puerto de Lizarraga, *Etayo*, MA 3727.

9. *Calicium salicinum* Pers.

Ann. Bot. (Usteri) 7: 20 (1794)

Thallus immersed. Capitulum and sometimes the upper part of the stalk with brown or orange-brown pruina. Asci subclavate to cylindrical, 35-50 x 5 µm. Ascospores 8-12 x 4-5.5 µm, with spiral ornamentation.

C. salicinum is a widespread and common species on the Iberian Peninsula but absent from oceanic areas. In the Mediterranean Region it is most frequent in the meso- and supramediterranean belts and sparsely distributed in the Eurosiberian Region (colline and montane belts). It grows on a great variety of wood, on deciduous trees (*Fagus sylvatica* and *Quercus pyrenaica*) in the north and centre, and bark of conifers (*Pinus nigra* and *Abies pinsapo*) in the south. It has a wide altitudinal range from 500 to 1450 m.

Material studied (Fig. 9): SPAIN: **Álava:** Cigoitia, Macizo de Gorbea, *Aguirre & Renobales*, 8-IV-1985, MAF. **Albacete:** Bienservida, sierra de Alcaraz, *Aragón et al.*, 25-IV-1997, MA 9265. Paterna del Madera, sierra de Alcaraz, *Aragón & Martínez*, 12-IV-1997, MA 9266. **Asturias:** Abhänge des Cordal de la Mesa Nunterdem, Puerto de Ventana, *Hafellner* n° 10514, 1-IX-1980, GZU. **Cáceres:** Villar del Pedroso, *Aragón & Martínez*, 4-I-1995, MA 7725. **Cantabria:** Campoo de Cabuérniga, *Aragón* 1323/96 & *Martínez*, 29-VI-1996, Herb. Aragón. **Ciudad Real:** Fuencaliente, *Sarrión & López*, 14-II-1996, Herb. Sarrión 169. "Ibídem", *Sarrión*, 29-I-1991, MACB 43898. Arroba de los Montes, *Sarrión*, 29-IX-1996, Herb. Sarrión 294. **Cuenca:** Serranía de Cuenca, *Aragón & Martínez* 2784, 2759, 14-III-1998, MA. **Guipuzcoa:** Gorostiaga, Legazpia, *Aguirre*, 23-III-1984, MAF 1664. **Huesca:** Biescas, *Sarrión et al.*, 9-IX-1994, Herb. Sarrión 131. **Jaén:** Segura de la Sierra, sierra de Segura, *Aragón & Martínez*, 15-V-1995, Herb. Aragón. **Málaga:** Ronda, *Etayo et al.*, 16-IV-1994, MA 5701. **Navarra:** Baraibar, San Miguel de Aralar, *Etayo*, 8-IX-1991, MA 3396. Valle de Goñi, *Etayo & Breuss*, 23-VII-1993, MA 5551. **Toledo:** San Pablo de los Montes, Montes de Toledo, *Aragón & Martínez*, 5-I-1995, MA 7703, 7704. **Zamora:** Galende, Lago de Sanabria, *Aragón* 1557/96 *et al.*, 7-IX-1996, MA.

10. *Calicium trabinellum* (Ach.) Ach.

Meth. Lich. Suppl.: 14 (1803)

Thallus immersed. Young apothecia with yellow pruina on the mazaedium and on the lower side of the capitulum. Stalk with hyaline envelope. Semimature ascospores with incomplete spiral ridges and irregularly cracked-areolate when mature. Ascospores 8-12.5 x 5-6.2 µm

This is a rare species in the Iberian Peninsula, although locally abundant in the Pyrenees (montane and subalpine belts). There is only one record from the Mediterranean Region (oromediterranean belt), viz. in the mountains of Sistema Ibérico. It was collected on decorticated trunks of *Pinus sylvestris* and *P. uncinata*. It has an altitudinal range from 1300 to 1800 m.

Material studied (Fig. 10): SPAIN: **Huesca**: Biescas, valle de Asieso, *Sarrión et al.*, 9-IX-1994, Herb. Sarrión 130. Benasque, valle de Estós, *Herrero*, 20-VIII-1996, Herb. Sarrión 386. **Navarra**: Isaba, Macizo de Añelarra, *Etayo & Diederich*, MA 3725. **Soria**: Sierra de Urbión, Laguna Negra, *Etayo & Breuss*, 26-VII-1993, MA 4116.

11. *Calicium viride* Pers.

Ann. Bot. (Usteri) 7: 20 (1794)

Thallus granular, well developed, green. Apothecia black, 1-1.5 mm tall. Capitulum with a brown pruina on the lower side. Asci clavate. Ascospores 12-13 x 6-7 μ m, with irregular cracks. Thallus K+ pale yellow or K+ yellow to orange, C-, KC- or KC+ reddish orange.

C. viride is scarce in the colline and supramediterranean belts. It is more frequent in the Eurosiberian Region growing on bark of deciduous trees (*Fagus sylvatica* and *Quercus robur*). It is locally abundant in humid areas and forested sites in the Spanish Mediterranean Region where it grows on bark of *Pinus nigra*. It was collected from 400 to 1500 m altitude.

Material studied (Fig. 11): SPAIN: **Albacete**: Molinicos, Calar del Mundo, *Aragón et al.*, 5-X-1996, MA 9268. Paterna del Madera, sierra de Alcaraz, *Aragón & Martínez*, 12-IV-1997, MA 9267. "Ibidem", *Aragón & Martínez*, 17-V-1997, MA 9269. **Cantabria**: Campoo de Cabuérniga, *Aragón et al.*, 1-IV-1994, MA 5125. **Ciudad Real**: Fuencaliente, *Sarrión et al.*, 5-II-1997, Herb. Sarrión 605. "Ibidem", *Sarrión*, 27-VI-1993, Herb. Sarrión 116. **Jaén**: Segura de la Sierra, sierra de Segura, *Aragón* 1070/96 & *Martínez*, Herb. Aragón. **Navarra**: Artikutza, *Renobales & Aguirre*, 10-V-1984, MAF 1663.

Chaenotheca (Th. Fr.) Th. Fr.

Acta Reg. Soc. Sci. Upsal. 3, 3: 250 (1860)

12. *Chaenotheca brunneola* (Ach.) Müll. Arg.

Mém. Soc. Phys. Hist. Nat. Genève 16 (2): 360 (1862)

Thallus immersed or granular-farinaceous, ecorticate, green. Photobiont *Trebouxia*. Apothecia 0.8-1.7 mm. Capitulum spherical, with poorly developed excipulum; lower side of the capitulum sometimes appears pruinose. Ascospores 3.5-4.5 μ m in diameter, smooth. Thallus Pd+ yellow, K-, C-, KC-.

This species has a scattered distribution in the Iberian Peninsula. It is most frequent in the colline belt growing on lignum and bark of coniferous and deciduous trees (*Abies alba*, *Fagus sylvatica*, *Quercus petraea* and *Q. robur*). In the Mediterranean Region it is abundant in shaded and moistened locations of the supramediterranean belt growing on bark of conifers, particularly *Pinus nigra* and lignum of *Abies pinsapo*. It has a wide altitudinal range from 100 to 1400 m.

Material studied (Fig. 12): SPAIN: **Albacete**: Riópar, Calar del Mundo, *Aragón et al.*, 10-II-1996, MA 7693. **Asturias**: Parque Nacional de Muniellos, Cangas de Narcea,

Hafellner n° 10193, 4-IX-1980, GZU. Muniellos, *Hafellner* n° 9799, 5-IX-1980, GZU. **Cantabria:** Campoo de Cabuérniga, *Aragón* 1320/96 & *Martínez*, 29-VI-1996, Herb. Aragón. **La Coruña:** Taboada, Fraga del Eume, *Sarrión*, 19-9-1995, Herb. Sarrión 114. **Jaén:** Siles, sierra de Segura, *Aragón* 864/96 & *Martínez*, 1-V-1996, Herb. Aragón. **Málaga:** Estepona, sierra Bermeja, *Etayo et al.* 18-IV-1994, MA 5737. **Navarra:** Oronoz-Mugaire, Señorío de Bértiz, *Etayo*, 30-I-1994, MA 5531. Carretera de Eugui-Irurita, collado Meaka, *Etayo*, 22-V-1994, MA 5785. Isaba, Macizo de Añelarra, *Etayo & Printzen*, 5-VIII-1993, MA 3726.

13. *Chaenotheca chrysocephala* (Turner ex Ach.) Th. Fr.

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Thallus well developed, forming a continuous crust of rather small, ecorticate, spherical, green-yellow to bright yellow granules. Photobiont *Trebouxia*. Apothecia 0.5-1 mm. Stalk with a dense greenish yellow pruina in the upper part. Capitulum with a well developed excipulum, with a dense yellowish green pruina in the lower side. Ascospores 6-10 x 3.5-5 µm, shortly ellipsoidal or spherical, with a coarse and irregular ornamentation. Thallus Pd-, K-, C-, KC-.

This is the most frequent *Chaenotheca* species in Spain. It grows on lignum of deciduous trees (*Fagus sylvatica*) in the Eurosiberian Region. In the Mediterranean Region it was collected on bark of several pines (*Pinus nigra*, *P. pinaster* and *P. sylvestris*), always in humid areas and well-established forests of the supra- and oromediterranean belts. Its altitude ranges from 900 to 1750 m. The European distribution given by LITERSKI (1992) is extended to the Sierra de Segura in southeastern Spain.

Material studied (Fig. 13): SPAIN: **Albacete:** Molinicos, Calar del Mundo, *Aragón et al.*, 5-X-1996, MA 9326. "Ibidem", *Aragón et al.*, 10-II-1996, MA 7694. Paterna del Madera, sierra de Alcaraz, *Aragón & Martínez*, 12-IV-1997, MA 9329. Bienservida, sierra de Alcaraz, *Aragón et al.*, 25-IV-1997, MA 9330. Bogarra, sierra de Alcaraz, *Aragón et al.*, 6-X-1996, MA 9328. **Cantabria:** Campoo de Cabuérniga, *Aragón* 1321/96 & *Martínez*, 29-VI-1996, Herb. Aragón. **Cuenca:** Serranía de Cuenca, Sierra de Valdecabras, *Aragón & Martínez* 30002, 17-III-1998, MA. Serranía de Cuenca, Las Torcas, *Aragón & Martínez* 2723, 14-III-1998, MA. Buenache de la Sierra, Serranía de Cuenca, *Aragón & Martínez* 2547, 7-III-1998, MA. **Jaén:** La Iruela, sierra de Cazorla, *Aragón* 0735/96 & *Rico*, 18-III-1996, Herb. Aragón. Segura de la sierra, sierra de Segura, *Aragón* 1070/96 & *Martínez*, 2-V-1996, Herb. Aragón. Siles, sierra de Segura, *Aragón* 0870/96 & *Martínez*, 1-V-1996, Herb. Aragón. **Lérida:** Massís del Moixeró, *Hladún*, 9-VII-1982 (Exiccata s.n.), MACB. **Soria:** San Leonardo de Yagüe, cañón del río Lobos, *Aragón & Martínez*, 9-III-1996, MA 7718. Santa María de las Hoyas, sierra de Nafría, *Aragón & Martínez*, 9-III-1996, MA 7719. **Teruel:** Orihuela del Tremedal, sierra de Albarracín, *Aragón et al.*, 19-V-1996, MA 7729. Alcalá de la Selva, sierra de Gúdar, *Aragón et al.*, 14-III-1997, MA 9769.

14. *Chaenotheca ferruginea* (Turner ex A. L. Sm.) Mig.

Krypt.-Fl. 4 Flechten 2: 479 (1931)

Thallus well developed, ecorticate, granular verrucose, pale whitish grey, often with limited yellow to rusty reddish patches. Photobiont *Trebouxia*. Apothecia

1-1.6 mm. Capitulum obconical with well developed excipulum. Ascospores 5.5-7.5 μm in diameter, spherical, coarsely and irregularly fissured when mature. Thallus Pd-, K-, C-, KC-, but areas containing a yellow-red pigment turn deep red with K.

Ch. ferruginea has ecology and distribution similar to *Ch. chrysocephala* in the Iberian Peninsula, although it grows in more continental areas and is less frequent. Widespread and common in the supramediterranean belt, at altitudes from 1250 m to 1600 m. It was collected on bark of conifers, often *Pinus nigra*, in moist situations and rarely on deciduous trees.

Material studied (Fig. 14): SPAIN: **Albacete**: Molinicos, Calar del Mundo, *Aragón et al.*, 5-X-1996, MA 9334. Villaverde de Guadalimar, Calar del Mundo, *Aragón et al.*, 11-II-1996, MA 7698. Riópar, Calar del Mundo, *Aragón et al.*, 10-II-1996, MA 7695. Paterna del Madera, sierra de Alcaraz, *Aragón & Martínez*, 12-IV-1997, MA 9332. "Ibidem", *Aragón & Martínez*, 17-V-1997, MA 9331. Bienservida, sierra de Alcaraz, *Aragón et al.*, 25-IV-1997, MA 9333. **Cuenca**: Buenache de la Sierra, Serranía de Cuenca, *Aragón & Martínez* 2558, 7-III-1998, MA. Serranía de Cuenca, *Aragón & Martínez* 2853, 14-III-1998, MA. **Jaén**: Siles, sierra de Segura, *Aragón & Martínez*, 1-V-1996, Herb. Aragón. **Soria**: San Leonardo de Yagüe, cañón del río Lobos, *Aragón & Martínez*, 9-III-1996, MA 7720. **Teruel**: Alcalá de la Selva, sierra de Gúdar, *Aragón 367/97 et al.*, 14-III-1997, MA.

15. *Chaenotheca furfuracea* (L.) Tibell

Beih. Nova Hedwigia 79: 664 (1984)

Thallus leprose, bright yellow-green. Photobiont *Stichococcus*. Apothecia 1.5-2.5 mm. Head and stalk with a yellowish green pruina. Ascospores 2-3 μm in diameter, spherical.

It is scarce on the Iberian Peninsula, being most frequent in the Eurosiberian Region. However, it is common in moist areas of the Mediterranean Region, especially in the supramediterranean belt. It was collected on bryophytes, tree bases and roots of coniferous (*Pinus nigra* and *P. sylvestris*) and deciduous trees, particularly *Fagus sylvatica*. The altitude ranges from 900 to 1500 m.

Material studied (Fig. 15): SPAIN: **Albacete**: Paterna del Madera, sierra de Alcaraz, *Aragón & Martínez*, 17-V-1997, MA 9335. "Ibidem", *Aragón & Martínez*, 12-IV-1997, MA 9336. **Cantabria**: Potes-Cervera de Pisuerga, Pesaguero, *Etayo et al.*, MA 3770. Campoo de Cabuérniga, *Aragón 1322/96 & Martínez*, 29-VI-1996, Herb. Aragón. **Cuenca**: Serranía de Cuenca, Las Torcas, *Aragón & Martínez* 2715, 14-III-1998, MA. Buenache de la Sierra, Serranía de Cuenca, *Aragón & Martínez* 2557, 7-III-1998, MA. **Jaén**: Siles, sierra de Segura, *Aragón 1687/97*, 18-VI-1997, Herb. Aragón. Segura de la Sierra, sierra de Segura, *Aragón 1788/97*, 19-VI-1997, Herb. Aragón. **Navarra**: Eugui, *Etayo*, MA 3751. **Teruel**: Alcalá de la Selva, sierra de Gúdar, *Aragón et al.*, 14-III-1997, MA 9770. **Zamora**: Cobrerros, valle de Sanabria, *Aragón & Martínez*, 2-V-1997, MA 9043.

16. *Chaenotheca phaeocephala* (Turner) Th. Fr.

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Thallus squamulose, verrucose, greenish brown. Photobiont *Trebouxia*. Apothecia 0.5-1.5 mm. Stalk with faint yellowish green pruina on the uppermost part. Capitulum obconical-lenticular with a well developed excipulum. Excipulum with $\pm$ dense pruina on the lower side. Ascospores 5.5-7.5 μ m in diameter, spherical, with irregular fissures. Thallus Pd-, K-, C-, KC-.

Ch. phaeocephala is a hemiboreal to southern boreal species with the nearest known localities in France and Italy (TIBELL 1980). With these new records its distribution is extended to southern Spain. It is sparsely distributed in the Mediterranean Region, at 900-1350 m, but locally abundant in subhumid coniferous forest in the supramediterranean belt of Sierras Béticas, growing on bark of *Pinus nigra*. New to the Iberian Peninsula.

Material studied (Fig. 16): SPAIN: **Albacete**: Villaverde de Guadalimar, Calar del Mundo, Aragón *et al.*, 11-II-1996, MA 7699. **Ciudad Real**: Fuencaliente, Sarrión, 2-5-1997, Herb. Sarrión. **Cuenca**: Serranía de Cuenca, Aragón & Martínez 2816, 14-III-1998, MA. Serranía de Cuenca, Cotillas, Aragón & Martínez 2760, 14-III-1998, MA. **Jaén**: Segura de la Sierra, sierra de Segura, Aragón 796/95 & Martínez, 15-V-1995, Herb. Aragón.

17. *Chaenotheca trichialis* (Ach.) Th. Fr.

Acta Reg. Soc. Sci. Upsal. 3, 3: 251 (1860)

Thallus granular-squamulose, greenish grey. Photobiont *Stichococcus*. Apothecia 1-2 mm. Capitulum obconical-lenticular with a well developed excipulum covered with a faint whitish pruina on the lower side. Ascospores 4-5 μ m in diameter, with irregular, narrow cracks. Thallus Pd-, K-, C-, KC-.

This species has a scattered distribution in the Spanish Eurosiberian Region (colline and montane belts), growing on lignum of *Fagus sylvatica* in forested sites. In the Mediterranean Region it was collected in humid areas and well established forests (coniferous and deciduous) of the supramediterranean belt. It has a wide altitudinal range from 200 to 1600 m.

Material studied (Fig. 17): SPAIN: **Albacete**: Paterna del Madera, sierra de Alcaraz, Aragón & Martínez, 12-IV-1997, MA 9337. **Asturias**: Sierra de Suevo, arroyo de la Corteguera, Etayo *et al.*, MA 3753. **Cantabria**: Al norte de Piedras Luengas, Etayo *et al.*, MA 3752. **Cuenca**: Serranía de Cuenca, Cotillas, Aragón & Martínez 2761, 14-III-1998, MA. **Jaén**: Siles, sierra de Segura, Aragón 1688/97, 18-VI-1997, Herb. Aragón. Segura de la Sierra, sierra de Segura, Aragón 1793/97, 19-VI-1997, Herb. Aragón. **La Rioja**: Tobía, sierra de la Demanda, Breuss & Etayo, 26-VII-1993, MA 5454.

Chaenothecopsis Vain.

Medd. Soc. Fauna Fl. Fenn. 57 (1): 70 (1927)

18. Chaenothecopsis debilis (Turner & Borrer ex A. L. Sm. & Sowerby) Tibell

Symb. Bot. Upsal. 21 (2): 45 (1975)

Lignicolous fungus with black apothecia. Epihymenium, exciple and stalk reddish brown. Stalk N+ violet-red. Ascospores 1-septate, $5.5-7.5 \times 2-2.5 \mu\text{m}$. Septum pigmentation $\pm$ equal to outer wall.

Ch. debilis is sparsely distributed in the montane and upper mesomediterranean belts of the Iberian Peninsula. It usually grows on lignum of deciduous trees, very often *Quercus faginea*, at 800-1400 m altitude. New to Spain.

Material studied (Fig. 18): SPAIN: **Asturias**: Puerto de Ventana, Cordal de la Mesa, *Hafellner* n° 10515, 1-IX-1980, GZU. **Ciudad Real**: Fuencaliente, Garganta de los Pozuelos, *Sarrión & López*, 14-II-1996, Herb. Sarrión 168. **Cuenca**: Serranía de Cuenca, *Aragón & Martínez* 2812, 14-III-1998, MA. **Navarra**: Abárzuza, Monasterio de Iranzu, *Etayo*, 12-X-1993, MA 4380. **Teruel**: Sierra de Albarracín, Barranco Hondo, *Sarrión*, 15-V-1991, Herb. Sarrión 40.

19. Chaenothecopsis hospitans (Th. Fr.) Tibell

Nova Hedwigia 60: 202 (1995)

Parasite or parasymbiont of *Haematomma ochroleucum*. Apothecia sessile to shortly stalked. Stalk 0.1-0.2 mm tall. Capitulum lenticular to hemiglobose, 0.2-0.3 mm in diameter, epihymenium brown, hymenium and hypothecium yellowish to olivaceous, K+ red-purple. Ascus cylindrical, $44-55 \times 4.5 \mu\text{m}$. Ascospores non-septate, ellipsoidal-fusiform, brown, darker in the centre, $6-9.5 \times 3-4.4 \mu\text{m}$, with surface minutely rugose with some irregular cracks.

This species, until now known from North and Central Europe (TIBELL & RYMAN 1995), was found very abundantly in Ciudad Real Province. It grows on *Haematomma ochroleucum* thalli, occurring in fissures and overhanging surfaces in shaded areas, sometimes accompanied by *Calicium corynellum*, at 500 to 1000 m altitude. New to the Iberian Peninsula.

Material studied (Fig. 19): SPAIN: **Ciudad Real**: Almodóvar del Campo, *Sarrión*, 19-II-1998, Herb. Sarrión 1916. Arroba de los Montes, Estrecho de las Hoces, *Sarrión et al.*, 8-XII-1996, Herb. Sarrión 411. "Ibidem", Estrecho del Guadiana, *Sarrión*, 29-VI-1997, Herb. Sarrión 1080. Fuencaliente, *Sarrión et al.*, 5-II-1997, Herb. Sarrión 595. "Ibidem", umbría de Dormideros, *Sarrión*, 2-5-1997 Herb. Sarrión 869. Solana del Pino, Morrón del Águila, *Sarrión et al.*, 4-II-1997, Herb. Sarrión 600.

20. *Chaenothecopsis pusilla* (Ach.) A. F. W. Schmidt
Mitt. Staatsinst. Allg. Bot. Hamburg 13: 153 (1970)

Apothecia black, internally dull greenish or brownish, K-, N-. Ascospores 1-septate, 4.5-8 x 2.2-3.5 μm with septum paler than outer wall.

Scattered in the Eurosiberian Region (colline and montane belt), and areas with oceanic influence in the western Mediterranean Region (meso- and supramediterranean belt). It has a wide altitudinal range from 75 to 1450 m, growing on dry poles, lignum, decorticated trunks of conifers, deciduous or sclerophyllous trees (*Abies*, *Arbutus*, *Olea*, *Quercus*).

Material studied (Fig. 20): SPAIN: **Cáceres**: Hoyos, sierra de Santa Olalla, *Aragón* 0791/96 *et al.*, 5-IV-1996, Herb. Aragón. **La Coruña**: Taboada, Fraga del Eume, *Sarrión*, 19-IX-1995, Herb. Sarrión 115. **Huesca**: Hayedo de Betato, Biescas, *Sarrión et al.*, 10-IX-1994, Herb. Sarrión 43. **Málaga**: Ronda, Cañada del Cuerno, *Etayo et al.*, 16-IV-1994, MA 5700. **Toledo**: Los Navalucillos, Montes de Toledo, *Sarrión*, 7-XII-1993, Herb. Sarrión 42.

21. *Chaenothecopsis pusiola* (Ach.) Vain.
Medd. Soc. Fauna. Fl. Fenn. 57 (1): 70 (1927)

Apothecia black with dark olivaceous-brown stalks, internally with a diffuse yellowish K+ red pigment. Ascospores 1-septate, 5.5-7.5 x 2.5 μm , with septum colourless to pale brown.

Ch. pusiola is a rare species in the Iberian Peninsula. It grows on decorticated trunks of deciduous trees, in humid forests of the Eurosiberian Region (colline belt), at 600 m altitude. It is widely distributed in central and northern Europe. New to Spain.

Material studied (Fig. 21): SPAIN: **Asturias**: Parque Nacional de Muniellos, N von Cangas de Narcea, *Hafellner* n° 10210, 4-IX-1980, GZU.

22. *Chaenothecopsis viridireagens* (Nádv.) A. F. W. Schmidt
Mitt. Staatsinst. Allg. Bot. Hamburg 13: 153 (1970)

Apothecia black with reddish tinge in the upper part of the stalk, capitulum and stalk K+ intensely green. Ascospores 6-7 x 2.5 μm , with septum paler than outer wall.

This is a very rare species only known from the Navarra Province (colline belt). It grows on lignum of *Castanea sativa* in high humidity areas at 400 m altitude.

Material studied (Fig. 22): SPAIN: **Navarra**: Ornoz-Mugaie, Parque Natural de Bértiz, *Etayo*, MA 5347.

Cyphelium Ach.

K. Sv. Vetensk.-Akad. Handl. 1815: 261 (1815)

23. Cyphelium inquinans (A. L. Sm.) Trevis.

Flora 45: 3 (1862)

Thallus verrucose, greyish. Apothecia sessile, 1-2 mm in diameter, black, with white pruinose margin. Ascospores 1-septate, 15-17 x 8-9 μm , uniseriate, broadly ellipsoid, brown with a finely striated surface and few irregular cracks when mature. Thallus Pd+ yellow, K+ yellow to brown, C-.

C. inquinans is rare in the Mediterranean Region, although locally abundant in subhumid and well established coniferous forests of *Pinus nigra*, at 1200-1500 m (supramediterranean belt) in the Sierras Béticas. It was collected together with *Calicium salicinum*, *C. viride*, *Chaenotheca ferruginea* and *Ch. trichialis*. It has also been reported from Baixo Alentejo (SAMPAIO 1970) and Navarra (ETAYO 1989).

Material studied (Fig. 23): SPAIN: **Albacete**: Paterna del Madera, sierra de Alcaraz, Aragón & Martínez, 12-IV-1997, MA 9324. **Jaén**: Segura de la Sierra, sierra de Segura, Aragón 1794/97, 19-VI-1997, Herb. Aragón.

24. Cyphelium lecideinum (Nyl.) Trevis.

Flora 45: 4 (1862)

Thallus faintly greenish grey and verrucose. Apothecia sessile, 0.5-0.8 mm in diameter, with white pruinose margin. Excipulum strongly thickened at the base. Ascospores 9-14 x 5-6 μm , striated and with irregular fissures when mature. Thallus Pd+ yellow, K+ yellow to red, C-, KC-.

This species is distributed in the southwest of the Iberian Peninsula (mesomediterranean belt) growing on siliceous rocks in warm and humid localities. It has also been reported in similar habitats from Tras-ós-Montes in Portugal (SAMPAIO 1970, TIBELL 1971) and Cádiz in Spain (ROWE & EGEA 1988).

Material studied (Fig. 24): SPAIN: **Sevilla**: Almadén de la Plata, finca "EL Berrocal", Rowe & Hafellner nos. 10398, 10400, GZU.

25. Cyphelium marcianum de Lesd.

Bull. Soc. Bot. France 55: 420 (1908)

Parasymbiont or parasite on saxicolous *Pertusaria* spp. Apothecia immersed, 0.5-0.8 mm in diameter. Excipular margin sometimes visible, black and not pruinose. Ascospores 11-13 x 6-8 μm , slightly constricted at septum. Mature ascospores coarsely spirally striated and with irregular cracks.

This species described from southern France and also occurring in Italy (NIMIS 1993) and northeastern Spain (HLADÚN 1984) grows on different silicicolous *Pertusaria* species. *C. marcianum* is considered to be a critically endangered species in the world (THOR 1996), and is rare in the meso- and supramediterranean belts from 900 to 1400 m altitude.

Material studied (Fig. 25): SPAIN: **Barcelona**: Sierra de Montseny, *Llimona*, 22-V-1983, GZU. **Castellón**: Pina de Montalgrao, sierra de Pina, 30SYK0234, *Calatayud et al.*, 12-X-1989, GZU.

26. *Cyphelium notarisii* (Tul.) Blomb. & Forssell

Enum. Plant. Scand. 1 (4): 95 (1880)

Thallus verrucose, yellowish green. Apothecia 0.5 mm in diameter, immersed, not pruinose. Ascospores 1-septate to submuriform, 18-30 x 11-17 μm . Thallus Pd-, K-, C-, KC-.

C. notarisii has a continental distribution on the Iberian Peninsula, and occurs at middle elevations from 930 to 1400 m. It grows on bark of conifers, usually *Pinus pinaster* and *P. sylvestris*, in humid and open localities. It has been reported from Alto Douro in Portugal (SAMPAIO 1970, TIBELL 1971). New to Spain.

Material studied (Fig. 26): SPAIN: **Madrid**: Rascafría, *Sanz*, XII-1982, MAF 1756. "Ibidem", 3-IV-1983, MAF 1757. **Soria**: Berlanga del Duero, *Aragón & Herrero*, 4-XI-1995, MA 7701. **Teruel**: Alcalá de la Selva, sierra de Gúdar, *Aragón et al.*, 14-III-1997, MA 9768.

27. *Cyphelium sessile* (Pers.) Trevis.

Flora 45: 4 (1862)

Parasymbiont or parasite on *Pertusaria* spp. Apothecia 0.5 mm in diameter, sessile, not pruinose. Ascospores 10-15 x 6-8 μm , constricted at septum. Mature ascospores coarsely spirally striated and with irregular cracks.

It has a suboceanic distribution from the Eurosiberian Region (colline and montane belts) to the western Mediterranean Region, in inland localities with humid influence. Its southern distributional limit is Sierra Madrona in Ciudad Real Province, although it is rare. It was collected on different epiphytic *Pertusaria* species, at 500-1100 m.

Material studied (Fig. 27): PORTUGAL: **Beira Litoral**: Póvoa de Lanhoso, Pormarelho, *Sampaio*, VI-1920, MA 1346 (G. Sampaio Lich. Port. n° 34). SPAIN: **Álava**: Altube, *Etayo*, MAF 1724. **Ciudad Real**: Fuencaliente, *Sanrión*, 30-IV-1990, Herb. Sanrión 566. **Guipuzcoa**: Gatzaga, Monte Usokoaitza, *Aguirre*, 6-XI-1983, MAF 3625. **Navarra**: valle de Baztán, collado Vendreka, *Breuss & Etayo*, 21-VII-1993, MA 5831. Alcoz, valle de la Ulzama, *Etayo*, MA 3775. valle de la Ulzama, Oroquieta, *Etayo*, 13-II-1994, MA 5520. **Pontevedra**: Monte Castro, *Crespí*, MA 1354. Armentera, *Crespí*, MA 1347.

28. *Cyphelium tigillare* (Ach.) Ach.

K. Sv. Vetensk.-Akad. Handl.: 266 (1815)

Thallus verrucose, yellowish green. Apothecia 0.3-0.7 mm in diameter, not pruinose, immersed in the verrucae. Ascospores 19-20 x 9-11 μm , broadly elliptical, smooth. Thallus Pd-, K-, C-, KC-.

C. tigillare is widespread in the Mediterranean Region, being rare in the Eurosiberian Region. It grows on hard lignum of conifers (*Juniperus oxycedrus* and *Pinus nigra*) in open situations at 800-1300 m. It has been reported from Navarra (ETAYO 1988) and Granada (AMO Y MORA 1870, LÁZARO-IBIZA 1920). With our new records the distribution published by TIBELL (1994) is extended considerably in southern Europe.

Material studied (Fig. 28): SPAIN: **Albacete**: Bienservida, sierra de Alcaraz, *Aragón et al.*, 25-IV-1997, MA 9325. **Ciudad Real**: Almodóvar del Campo, *Sarrión*, 19-II-1998, Herb. *Sarrión* 1935. Arroba de los Montes, *Sarrión*, 29-VI-1997, Herb. *Sarrión* 1084. Fuencaliente, Abulagoso, *Sarrión*, 27-6-1993, Herb. *Sarrión* 226. Fuencaliente, sierra de Dormideros, *Sarrión*, 30-V-1993, Herb. *Sarrión* 180, MACB 43962. **Jaén**: Santiago-Pontones, sierra de Segura, *Aragón* 236/95 & *Martínez*, 21-III-1995, Herb. *Aragón*. Segura de la Sierra, sierra de Segura, *Aragón* 793/95 & *Martínez*, 15-V-1995, Herb. *Aragón*. **Toledo**: Los Navalucillos, Montes de Toledo, *Aragón* & *Martínez*, 26-III-1995, MA 7706. "Ibidem", *Sarrión*, 7-XII-1993, MA 5246. "Ibidem", *Sarrión*, 13-VI-1994, Herb. *Sarrión* 44.

Mycocalicium Vain.

Jahrb. wiss. Bot. 28: 84 (1895)

29. *Mycocalicium subtile* (Pers.) Szatala

Magyar Bot. Lapok 24: 47 (1926)

Saprophytic. Apothecia black, up 2 mm tall. The stalk is rather variable in section, pigmented from greyish brown (K- or K+ slightly brown) to reddish brown. This variability in the internal structure was also pointed out by TIBELL (1984). Ascospores allantoid to ellipsoidal, 7-11 x 3-5 μm .

M. subtile is common on the Iberian Peninsula, being more frequent in the Mediterranean Region, from meso- to oromediterranean belts. It grows on lignum and old barks of various trees (*Abies*, *Fraxinus*, *Juniperus*, *Olea*, *Sorbus* and *Taxus*), often on *Quercus* and *Pinus* in $\pm$ open forest, from 600 to 1800 m altitude.

Material studied (Fig. 29): SPAIN: **Albacete**: Riópar, Calar del Mundo, *Aragón et al.*, 10-II-1996, MA 7697. Yeste, Calar del Mundo, *Aragón* & *Rico*, 16-III-1996, MA 7723. Vianos, Calar del Mundo, *Aragón* & *Martínez*, 5-I-1996, MA 7692. Paterna del Madera, sierra de Alcaraz, *Aragón* & *Martínez*, 12-IV-1997, MA 9476. **Cádiz**: Benamahoma, sierra del Pinar, *Sarrión*, 23-III-1991, Herb. *Sarrión* 56. **Cáceres**: San Martín de Trevejo, sierra de Gata, *Aragón et al.*, 4-IV-1996, MA 7726. Villar del Pedroso, Garganta del Mesta, *Aragón* & *Martínez*, 4-I-1995, MA 7717. **Ciudad Real**: Almodovar, Puerto del Mochuelo, *Sarrión*, 30-VI-1995, Herb. *Sarrión* 49. Arroba de

los Montes, *Sarrión*, 17-III-1996, Herb. Sarrión 160. Fuencaliente, Garganta de los Pozuelos, *Sarrión & López*, 14-II-1996, Herb. Sarrión 163, 165. Fuencaliente, Umbría de Dormideros, *Sarrión*, 30-VI-1992, Herb. Sarrión 48. "Ibidem", 4-I-1991, MACB 43921. Fuencaliente, Peña Escrita, *Sarrión*, 4-VII-1996, Herb. Sarrión 261. Viso del Marqués, *Sarrión*, 7-X-1992, Herb. Sarrión 123. **Cuenca**: Serranía de Cuenca, Sierra de Valdecabras, *Aragón & Martínez* 3024, 17-III-1998, MA. Serranía de Cuenca, Cotillas, *Aragón & Martínez* 2762, 14-III-1998, MA. Buenache de la Sierra, Serranía de Cuenca, *Aragón & Martínez* 2525, 7-III-1998, MA. Serranía de Cuenca, Cotillas, *Aragón & Martínez* 2763, 14-III-1998, MA. **Huesca**: Carretera de Sabinánigo a Boltaña, Puerto de Serrablo, *Etayo*, 5-XII-1993, MA 5675. **Jaén**: La Iruela, sierra de Segura, *Aragón* 708/95 & *Martínez*, 14-V-1995, Herb. Aragón. Aldeaquemada, *Sarrión*, 21-V-1994, Herb. Sarrión 51. Andújar, *Sarrión*, 12-III-1995, Herb. Sarrión 53. Villarrodrigo, *Sarrión*, 19-III-1995, Herb. Sarrión 52. **Málaga**: Ronda, Cañada del Cuerno, *Etayo et al.*, 16-IV-1994, MA 5704. Parauta, sierra de las Nieves, *Sarrión*, 3-I-1993, Herb. Sarrión 55, 47. **Soria**: Recuerda, *Aragón*, 7-X-1995, MA 6883. San Esteban de Gormaz, Torremocha de Ayllón, *Aragón & Herrero*, 4-XI-1995, MA 7702. San Leonardo de Yagüe, cañón del río Lobos, *Aragón & Martínez*, 9-III-1996, MA 7721. Ucleo, sierra de Nafría, *Aragón & Martínez*, 9-III-1996, MA 7722. **Teruel**: Noguera, sierra de Albarracín, *Aragón et al.*, 18-V-1996, MA 7727. Orihuela del Tremedal, sierra de Albarracín, *Aragón et al.*, 19-V-1996, MA 7728. Griegos, Muela de San Juan, *Sarrión*, 15-V-1991, Herb. Sarrión 57. Alcalá de la Selva, sierra de Gúdar, *Aragón* 285/97 & *Martínez*, 9-II-1997, MA. **Toledo**: Los Navalucillos, Montes de Toledo, *Aragón et al.*, 2-IV-1995, MA 7707. "Ibidem", *Aragón & Martínez*, 26-III-1995, MA 7705. "Ibidem", *Sarrión*, 13-VI-1993, Herb. Sarrión 54. "Ibidem", *Aragón et al.*, 11-II-1995, MA 7714. **Zamora**: Cobrerros, Lago de Sanabria, *Aragón* 1459/96 *et al.*, 6-IX-1996, Herb. Aragón.

30. *Mycocalicium victoriae* (C. Knight ex F. Wilson) Tibell
Beih. Nova Hedwigia 79: 672 (1984)

Saprophytic. Apothecia robust, black. Stalk black, K+ reddish, in section pale in central part and reddish in the outer part. Exciple well developed of isodiametric to elongated cells. Outer layer of excipulum of isodiametric cells with pigmented walls. Yellowish hypothecium, K+ yellow. Ascospores 8-9 x 3.5-4.5 µm brown, fusiform to ellipsoidal.

This rare species was previously only known from Australia, New Zealand (TIBELL 1984) and the Canary Islands (HERNÁNDEZ PADRÓN *et al.* 1992). As reported before (SARRIÓN *et al.* 1993), the here cited localities are the first ones in Europe. It was collected on lignum of deciduous trees (*Quercus pyrenaica*) in subhumid microclimate conditions at 900 m-1000 m being locally abundant.

Material studied (Fig. 30): SPAIN: **Ciudad Real**: Fuencaliente, sierra de Navalmanzano, *Sarrión*, 16-XI-1991, Herb. Sarrión 124. Fuencaliente, Fuente del Almirez, *Sarrión*, 26-VI-1993, Herb. Sarrión 58. Fuencaliente, sierra de Quintana, *Sarrión*, 16-XI-1991, MACB 43924. Fuencaliente, Umbría de Dormideros, *Sarrión*, 3-I-1991, MACB 43923, Herb. Sarrión 151. Fuencaliente, arroyo del Robledo de las Hoyas, *Sarrión et al.*, 5-II-1997, Herb. Sarrión.

Sclerophora Chev.

Fl. Gén. Envir. Paris 1: 315 (1826)

31. Sclerophora nivea (Hoffm.) Tibell

Beih. Nova Hedwigia 79: 679 (1984)

Thallus immersed. Photobiont *Trentepohlia*. Apothecia 0.3-0.9 mm tall. Excipulum well-developed. Capitulum spherical, lower surface of capitulum and stalk pale yellow, translucent when wet. Young apothecia sessile with yellow pruina. Ascospores 7-8 μm , spherical, with a minute verrucose ornamentation. Spore mass pale brown when mature, K+ purple-violet.

S. nivea is a very rare species in the Iberian Peninsula occurring in colline and supramediterranean belts. It grows on bark of deciduous (*Quercus faginea*) and sclerophyllous (*Quercus rotundifolia*) trees in humid conditions at open situations. It has a narrow altitudinal range from 850 to 1200 m.

Material studied (Fig. 31): SPAIN: **Jaén**: Orcera, sierra de Segura, Aragón 1462/97, 17-VI-1997, Herb. Aragón. **Navarra**: Abárzuza, pista del Monasterio de Iranzu, Etayo, 12-X-1993, MA 4399.

Sphaerophorus Pers.

Ann. Bot. (Usteri) 7: 23 (1794)

32. Sphaerophorus fragilis (L.) Pers.

Ann. Bot. (Usteri) 7: 23 (1794)

Thallus fruticose with cylindrical, more or less dichotomous branches, forming dense tufts. Medulla I-. All the specimens were sterile. Sphaerophorin, squamatic acid, hypothamnolic acid, and some unidentified substances were detected with TLC representing two chemotypes. Most of material previously recorded as *S. fragilis* has been misidentified because of a poor I+ reaction.

This is a very rare species collected in northern Portugal and the oromediterranean belt of the Cordillera Cantabrica at the boundary with the Eurosiberian Region. It grows on acid muscicolous rocks (quartzitic). Its altitudinal range is from 1600 to 2000 m.

Material studied (Fig. 32): Sphaerophorin and squamatic acid chemotype: SPAIN: **Cantabria**: Puerto de San Glorio, Vega de Tarna, Burgaz, 7-VI-1994, MA 5171. Sphaerophorin and hypothamnolic acid chemotype: PORTUGAL: **Douro**: Serra do Marão, Teixeira, V-1952, LISU 5168. **Minho**: Serra do Gêrez-Carris, Tavares, 25-III-1948, LISU 2474. Serra do Gêrez-Borrageira, Tavares, 19-VII-1947, LISU 2108. "Ibidem", Tavares, 3-VII-1948, LISU 2737.

33. *Sphaerophorus globosus* (Huds.) Vain.

Res. Voy. S. Y. Belgica, Bot.: 35 (1903)

Thallus fruticose with main branches distinct, not very densely branched, and tips often lighter. Medulla I+ dark blue. Only one specimen was found fertile. Ascospores spherical, 7.5 μ m diameter.

Three chemotypes were distinguished (see material studied). It is not easy to find relationships between different chemotypes and ecological conditions in the Iberian Peninsula. Nevertheless, samples containing squamatic acid have the widest inland distribution reaching continental locations in the Mediterranean Region, while samples containing hypothamnolic acid are restricted to hyperoceanic areas of the Iberian Peninsula. The relation between humid conditions and the production of the thamnolic acid has noted several times in *Cladonia* (HUOVINEN & AHTI 1982, STENROOS & AHTI 1990, GOWARD & AHTI 1990).

S. globosus is widespread in the north and sparsely distributed in oceanic areas of the southwestern Iberian Peninsula. It is a hygrophilous species growing on soil, rock and bark of deciduous trees in oceanic and suboceanic areas with a wide altitudinal range from 50 to 2000 m.

Material studied (Fig. 33): Sphaerophorin and squamatic acid chemotype: PORTUGAL: **Beira Alta**: Serra da Estrela, *Rivas Martínez & Costa*, V-1972, MAF 2117. Serra da Estrela, Senhora do Destêrro, *Tavares*, VIII-1946, LISU 1321. Serra da Estrela, *Tavares*, 4-VIII-1962, LISU 6815. Serra da Estrela, Lagoa Comprida, 1650 m, *Palhinha*, 7-VIII-1940, LISU 1141. Serra do Caramulo, próx. do Sanatorio do Sameiro, *Tavares*, 28-IX-1942, LISU. **Estremadura**: Serra de Sintra-Peninha, *Tavares*, 21-III-1947, LISU 928. **Minho**: Serra do Gêrez, Leonte, *Tavares*, 30-VII-1944, LISU 929. "Ibidem", *Tavares*, 19-VI-1947, LISU 2106. Vieira, Crasto de Cantelães, 550 m, *Palhinha*, 3-X-1942, LISU. **Tras-os-Montes**: Convelho de Boticas, entre Campo e Viveiro de Covas, *Santos*, 2-IX-1949, LISU 3212. SPAIN: **Asturias**: Puerto Ventana, *Ron*, 11-VIII-1970, MACB 5275. **León**: Puerto de Panderrueda, *Moral*, 11-VIII-1985, MA 4081. **Lugo**: Sierra de los Ancares, 25-III-1978, MACB 43206. **Madrid**: Sierra de Guadarrama, *Crespo*, VI-1970, MAF 2116. **Orense**: Cumbre de Peña Nofre, *Crespo*, 18-VI-1980, MAF 1468. **Pontevedra**: La Fracha, *Crespi*, MA 2756. **La Rioja**: Lumberras, *Burgaz*, 22-X-1983, MACB 14673. **Segovia**: Riofrio de Rianza, valle del río Rianza, *Martínez*, 4-III-1994, MA 5112. **Zamora**: Ribadelago Viejo, *Burgaz*, 6-IV-1989, MACB 64767. Sphaerophorin and hypothamnolic acid chemotype: PORTUGAL: **Algarve**: Serra de Monchique, *Palhinha*, LISU 930. Serra de Monchique-Foia, *Tavares*, 30-IV-1947, LISU 1827. **Minho**: Povia de Lanhoso, *Sampaio*, VI-1920, MA 2758. SPAIN: **Asturias**: Teverga, puerto Ventana, *Fuente*, MA 4082. **Lugo**: Los Ancares, *Frenández*, 14-IV-1973, MAF 970. **Navarra**: Isaba, Refugio de Belagua, *Etayo*, 24-IX-1995, MA 6600. **Vizcaya**: Macizo de Gorbea, Ceámuri, *Aguirre & Renobales*, 8-IV-1985, MA 3499, MACB 39127. Sphaerophorin, squamatic and hypothamnolic (traces) acids: SPAIN: **Asturias**: Collado de las Chabolas, Puerto del Connio, *Campo & Braña*, 27-XII-1977, MAF 2091. **Cantabria**: Campoo de Cabuérniga, *Aragón et al.*, 1-IV-1994, MA 5170. **Navarra**: Bera de Bidasoa, *Etayo*, 31-X-1993, MA 5877. **Soria**: Sierra de Urbión, Laguna Negra, *Etayo & Breuss*, 26-VII-1993, MA 4117.

Sphinctrina Fr.

Elench. Fung. 2: 148 (1828)

34. Sphinctrina tubaeformis A. Massal.

Mém. Lichenogr.: 155 (1853)

Parasitic or parasymbiotic. Apothecia 0.1-0.3 mm, sessile or short-stalked. Excipulum dark brown in section, K-. Ascospores 10-14 x 5-7.5 μm , ellipsoidal, with ornamentation of reticulately connected ridges.

This species is sparsely distributed in oceanic areas of the colline belt (Eurosiberian Region) at altitudes of 100 to 500 m. It always grows on thalli of *Pertusaria leioplaca*.

Material studied (Fig. 34): PORTUGAL: **Douro Litoral**: Porto, Paraulios, *Sampaio*, XII-1915, COI. Figueiras, Alfarrobeiras, *Cardoso*, IV-1904, COI. SPAIN: **Pontevedra**: Marcón, *Crespi*, MA 2762. "Ibidem", MA 2760. Cangas, *Crespi*, MA 2761.

35. Sphinctrina turbinata (Pers.) De Not.

Giorn. Bot. Ital. 2: 314 (1846)

Parasitic or parasymbiotic. Apothecia 0.2-0.4 mm short stalked. Excipulum dark reddish brown in section, K+ red. Ascospores 6-7 x 5-7 μm , $\pm$ globose, with ornamentation of minute warts and some irregular cracks when mature.

S. turbinata has a scattered distribution in the northern and western areas of the Iberian Peninsula (montane and upper mesomediterranean belts), being absent from the east. It was collected on thalli of *Pertusaria* and *Caloplaca* species, with wide altitudinal range (from 700 to 2000 m).

Material studied (Fig. 35): PORTUGAL: **Algarve**: Östliches Algarve bei Tavira, April-1961, Poelt 5069, GZU. Vila Viçosa, Hudade da Ribeira, *Fernandes & Botelho*, 10-V-1947, n° 96, COI. SPAIN: **Asturias**: Parque Nacional de Muniellos, Cangas de Narcea, *Hafellner* n° 10209, 4-IX-1980, GZU. **Ciudad Real**: Fuencaliente, Umbría de Dormideros, *Sarrión*, MACB 43928. Fuencaliente, sierra de Fuencaliente, *Sarrión*, 25-V-1996, Herb. *Sarrión* 188. **Cantabria**: Argüebanes, *Etayo et al.*, MA 4001. **Madrid**: Hayedo de Montejo, *Crespo & Barreno*, XII-1972, MAF-Lichenes 2118. **Navarra**: Sierra de Urbasa, *Etayo & Diederich*, 20-7-1991, MA 3530.

Thelomma A. Massal.

Mém. Lichenogr.: 155 (1853)

36. Thelomma siliceum (Fée) Tibell

Bot. Notiser 129: 243 (1976)

Thallus verrucose-areolate, well developed, greyish. Apothecia black 0.6-0.8 mm in diameter. Ascospores 10-14 μ m in diameter, non-septate and $\pm$ spherical. Surface of the mature ascospores very irregular.

Thelomma siliceum is widespread along the atlantic Mediterranean Region, growing on siliceous rocks, with humid climate, at 800-1000 m altitude. It has been reported from Alto Alentejo, Baixo Alentejo and Tras-os-Montes in Portugal (SAMPAIO 1970, TIBELL 1976). New to Spain.

Material studied (Fig. 36): SPAIN: **Asturias**: San Antolín-Cangas de Narcea, W del paso El Connio, *Hafellner* n° 10697, 5-IX-1980, GZU.

The following species have been recorded by other authors and are included to supplement the information on calicioid fungi and mazaediate lichens of the Iberian Peninsula. All of them are very rare and mostly restricted to the north of the Iberian Peninsula. As we have not been able to check the specimens, no description or maps are given.

Chaenotheca brachypoda (Ach.) Tibell. Only two references from bark crevices of deciduous trees (*Quercus* and *Tilia*) in montane belt. Alt.: 500-600 m. SPAIN: **Navarra** (ETAYO *et al.* 1993).

Chaenotheca chlorella (Ach.) Müll. Arg. On bark of deciduous trees (*Quercus*). Only known from montane belt. Alt.: 785 m. SPAIN: **Navarra** (ETAYO *et al.* 1993).

Chaenotheca hispidula (Ach.) Zahlbr. On bark of deciduous trees (*Quercus*). Colline and montane belts. Alt.: 200-500 m. SPAIN: **Lugo** (ÁLVAREZ & CARBALLAL 1989, ETAYO *et al.* 1991) and **Navarra** (ETAYO & GÓMEZ BOLEA 1992).

Chaenotheca stemonea (Ach.) Müll. Arg. On bark of deciduous trees (*Quercus* and *Tilia*). Montane belt. Alt.: 50-300 m. SPAIN: **Pontevedra** (CARBALLAL & GARCÍA MOLARES 1988).

Chaenotheca xyloxena Nádv. On bark and lignum of coniferous trees (*Pinus*), in humid and subhumid situations. Montane and subalpine belt. Alt.: 1300-1800 m. SPAIN: **Huesca** (TIBELL 1980) and **Lérida** (HLADÚN 1984).

Chaenothecopsis savonica (Räsänen) Tibell. On lignum of deciduous trees (*Quercus*). Alt.: 1100 m. SPAIN: **Navarra** (ETAYO *et al.* 1993).

Microcalicium disseminatum (Ach.) Vain. On bark of deciduous and coniferous trees. Alt.: 1000 m. SPAIN: **Álava** (ETAYO 1992), **Madrid** (NAVÁS 1899) and **Navarra** (ETAYO 1990).

Phaeocalicium populneum (Brond. ex Duby) A. F. W. Schmidt. Rare, very old references. On dying twigs and branches of *Populus tremula*. Alt.: 500 m-1200 m. PORTUGAL: **Douro** and **Minho** (SAMPAIO 1921). SPAIN: **Huesca** (LÁZARO IBIZA 1920).

Sphinctrina anglica Nyl. On *Quercus pyrenaica*, lichen substrate unknown. It might be parasitic on some species of *Lecanora*. Alt.: 1200 m. SPAIN: **Salamanca** (MARCOS 1986).

Sphinctrina leucopoda Nyl. On thalli of *Pertusaria* spp. Alt.: 750-1200 m. PORTUGAL: **Algarve**: (BENTO PEREIRA 1981, BOOM & GIRALT 1996).

Estremadura: (BENTO PEREIRA 1981). SPAIN: **Álava** (SANTESSON 1960, ETAYO 1992), La Coruña (ETAYO *et al.* 1991), y **Salamanca** (MARCOS 1986).

Stenocybe major Körber. On bark of *Abies alba*. Alt.: 1500 m. SPAIN: **Navarra** (ETAYO 1988).

Stenocybe pullatula (Ach.) Stein. On bark of deciduous trees. Alt.: 470 m. SPAIN: **Navarra** (ETAYO & GÓMEZ BOLEA 1992).

Thelomma mammosum (Hepp) A. Massal. On siliceous rocks. Alt.: 700-800 m. PORTUGAL: **Estremadura** (TIBELL 1976).

DISCUSSION

The atmospheric humidity and microhabitat conditions together with the existence of old trees, snags and decaying logs seem to be necessary in northern Europe for the diversity of mazaediate lichens and calicioid fungi (HOLLEN 1996). However, in summer southwestern Europe (mostly included in the Mediterranean Region) has drier conditions than the Eurosiberian Region, but the existence of several mountains with a wide variety of vegetation types and microclimatic conditions, allows the presence of many favourable habitats for the colonisation of these species.

So far, 49 species of mazaediate lichens and calicioid fungi have been reported from the Iberian Peninsula (36 recorded in this study plus 13 published by other authors). This number is comparable to 52 species known from Italy (NIMIS 1993). However, many unexplored areas still remain, especially in Portugal. An attempt to a provisional biogeographical grouping in the Iberian Peninsula is presented following the large scale zonal distribution patterns established by TIBELL (1994).

Many antitropical species are widespread in the Iberian Peninsula, having been collected at different altitudes and substrates (lignum, bark of deciduous and coniferous trees), such as *Calicium abietinum*, *C. glaucellum*, *C. salicinum*, *C. trabinellum*, *Chaenotheca chrysocephala*, *Ch. ferruginea*, *Ch. trichialis*, *Chaenothecopsis debilis*, *Ch. pusilla*, *Mycocalicium subtile* and *Sphinctrina leucopoda*. A subgroup avoiding continental situations is found in the Eurosiberian Region, viz. in oceanic to suboceanic habitats, consisting by *Calicium adspersum*, *Chaenotheca brachypoda*, *Ch. chlorella*, *Ch. hispidula*, *Ch. stemonea*, *Ch. xyloxa*, *Chaenothecopsis pusiola*, *Ch. savonica* and *Ch. viridiregens*.

A high representation of species is restricted to the northern hemisphere: *Calicium corynellum*, *C. viride*, *Chaenotheca furfuracea*, *Ch. phaeocephala*, *Cyphelium notarisii*, *C. tigillare*, *Microcalicium disseminatum*, *Sphinctrina turbinata* and *Sclerophora nivea*. Within this group *Calicium denigratum*, *Phaeocalicium populneum*, *Stenocybe major* and *S. pullatula* are restricted to the Eurosiberian Region.

Among the hygrophilous species, *Sphaerophorus fragilis* and *S. globosus* are considered less affected by special microhabitats (HOLIEN 1996), but a relation between distributional pattern and chemical composition is observed in the Iberian Peninsula. Thalli producing hypothamnolic acid are restricted to more oceanic areas while thalli with squamatic acid are less dependent on oceanity.

The European species *Chaenothecopsis hospitans*, *Cyphelium lecideinum* and *C. sessile* are parasymbionts or parasites widespread on saxicolous or epiphytic thalli, while *Calicium quercinum* is not a parasite and only appears in northern Spain.

Calicium lenticulare and *Chaenotheca brunneola* are considered azonal species and are locally abundant. However, the latter is restricted to the Eurosiberian Region.

The group of tropical and subtropical species is represented by *Calicium hyperelloides*, *Sphinctrina tubaeformis*, *Mycocalicium victoriae* and *Thelomma mammosum* which are distributed in hyperatlantic areas of western Iberian Peninsula, except for the latter two which occur in small areas of southern Spain.

The European endemics *Cyphelium marcianum* and *Thelomma siliceum* are distributed in northeastern Spain and western Iberian Peninsula respectively.

Cyphelium inquinans and *Sphinctrina anglica* are very rare species in the study area, so that it was difficult to make any definitive conclusion as to their ecological requirements and distribution.

Acknowledgements: We are grateful to Dr. L. Tibell for identifications/verifications of critical species, to Prof. T. Ahti for his generous help and advice, and Dr. I. Martínez for her generosity with collections. A. R. Burgaz received financial support from the Universidad Complutense de Madrid to visit the University of Graz and wishes to present her special thanks to Dr. J. Hafellner for his advice.

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Fig. 1. *Calicium abietinum*



Fig. 2. *Calicium adpersum*



Fig. 3. *Calicium corynellum*



Fig. 4. *Calicium denigratum*



Fig. 5. *Calicium glaucellum*



Fig. 6. *Calicium hyperelloides*



Fig. 7. *Calicium lenticulare*



Fig. 8. *Calicium quercinum*



Fig. 9. *Calicium salicinum*



Fig. 10. *Calicium trabinellum*



Fig. 11. *Calicium viride*



Fig. 12. *Chaenotheca brunneola*



Fig. 13. *Chaenotheca chrysocephala*



Fig. 14. *Chaenotheca ferruginea*



Fig. 15. *Chaenotheca furfuracea*



Fig. 16. *Chaenotheca phaeocephala*



Fig. 17. *Chaenotheca trichialis*



Fig. 18. *Chaenothecopsis debilis*



Fig. 19. *Chaenothecopsis hospitans*



Fig. 20. *Chaenothecopsis pusilla*



Fig. 21. *Chaenothecopsis pusiola*



Fig. 22. *Chaenothecopsis viridireagens*



Fig. 23. *Cyphelium inquinans*



Fig. 24. *Cyphelium lecideinum*

Fig. 25. *Cyphelium marcianum*Fig. 26. *Cyphelium notarisii*Fig. 27. *Cyphelium sessile*Fig. 28. *Cyphelium tigillare*Fig. 29. *Mycocalicium subtile*Fig. 30. *Mycocalicium victoriae*

Fig. 31. *Sclerophora nivea*Fig. 32. *Sphaerophorus fragilis*Fig. 33. *Sphaerophorus globosus*Fig. 34. *Sphinctrina tubiformis*Fig. 35. *Sphinctrina turbinata*Fig. 36. *Thelomma siliceum*

NEW SPECIES IN THE LICHEN GENUS *PARMOTREMA* (*PARMELIACEAE ASCOMYCOTINA*) FROM SOUTHERN BRAZIL

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ABSTRACT: Four species of *Parmotrema* Mass. from southern Brazil are described as new: *P. dactylosum* Fleig, *P. dissimile* Fleig, *P. horridum* Fleig and *P. praeisidiosum* Fleig.

Key words: taxonomy, lichens, *Parmotrema*, Brazil.

This study is based on specimens collected by the author for research on the large lobed *Parmeliaceae* from southern Brazil (Fleig, 1997). The material is stored in the ICN Herbarium (Departamento de Botânica da Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil). As a result, four new *Parmotrema* species are described. Specimens were analysed on morphological characters by stereoscopic and light microscope, and on their chemical constituents by colour tests and thin layer chromatography. Specimens were authenticated by type-specimens.

All the new species are saxicolous. Three of them belong to the *Parmotrema* species with a more adpressed thallus, narrow lobed, eciliate, and with narrow brown margins on the lower surface. *Parmotrema dactylosum* is similar to *P. tsavoense* (Krog & Swinscow) Krog & Swinscow (Krog & Swinscow, 1981, 1983), *P. alidactylatum* Estrabou & Adler, or *P. soredioaliphaticum* Estrabou & Adler (Estrabou & Adler, 1998), but the conidia are weakly bifusiform, 5-7,5 µm long and caperatic acid is present in the medulla. *P. dissimile* is similar to *P. dactylosum*, but the dactils becoming granulous, and norlobaridon and loxodic acid are present in the medulla; it also has morphological similarity to *P. praesorediosum* (Nyl.) Hale (Hale, 1965, 1974), *P. mordenii* (Hale) Hale (Hale, 1971, 1974) and *P. soredioaliphaticum*. *P. horridum* is similar to *P. mellissii* (Dodge) Hale (Dodge, 1959, Hale, 1971) but has olivetoric acid in the medulla. *P. praeisidiosum* has a small thallus similar to *P. peralbidum* (Hale) Hale (Hale, 1965, 1974) and approaches *P. praesorediosum* in its saxicolous habit and production of aliphatic acids.

The pantropical to south temperate species *P. praesorediosum* is widely distributed in south Brazil in stone fields or scrubland (Fleig, 1997). The African

species *P. tsavoense*, according to Krog and Swinscow (1981), was formerly known only from the type locality, and *P. mordenii* is described as a Mexican species (Hale, 1971), while *P. alidactylatum* and *P. soredioaliphaticum* are restricted to Argentina (Estrabou & Adler, 1998). The new species *P. dactylosum* is widely distributed in mountainous areas in Rio Grande do Sul State; *P. horridum* is also on mountainous areas, but is more restricted in its distribution, while *P. dissimile* and *P. praeisidiosum* are known only from their type localities.

THE SPECIES

Parmotrema dactylosum Fleig, sp. nov.
= *Parmotrema* sp. 1 (Fleig, 1997)

Fig. A

Thallus adnatus, saxicola, glaucescens, 10-15 cm diametro, lobis rotundatis 4-10 mm latis, pro parte imbricatis, ciliis destitutus, superne opacus, laevigatus, emaculatus, demum rugosus, dactylosus, dactyliis versus centrum congestis, simplicibus aut ramosis interdum pustulatis-sorediatis, sorediis diffusis, granulatis; medulla alba; subtus niger, sparse rhizinosus, ambito fusco-castaneus, papillatus, anguste nudus; apothecia rara, suburceolata, imperforata, 3-5 mm diametro, subpedicellata, base constricta, amphithecia dactylosa, sporae 12,5-16x7-10 μ m, episporio 1,3 μ m crasso; pycnidia rara, conidia sublageniformia vel bifusiformia 5-7,5 μ m longa; atranorinum, acidum caperaticum et acidis aliphaticis continente.

Type: BRAZIL, Rio Grande do Sul, municipio de Viamão, Itapuã, low hill in rocky scrubland, 26.09.1992, M. Fleig 4486 (ICN 73643).

Thallus 10-15 cm diam., attached, saxicolous, membranaceous to subcoriaceous, white-grey or bright-yellow when stored; lobe 4-10 mm wide, apices subconcave, margin even to subundulate, lateral margin subundulate, imbricate or ascending and involute, entire, eciliate; upper surface immaculate, the distal area even or subrugose, turning rugose and dactylose in the central area, dactyls marginal and laminar, sometimes dense in the central area, simple or sparsely branched, sometimes breaking out exposing the swollen medulla, or pustulate and producing granular soredia; medulla white; lower surface black, bright brown in the narrow marginal area, rhizines scattered, short, simple, coalescing or subramose; laminar apothecia infrequent, imperforate, 3-5 mm diam., suburceolate, substipitate, subinvolute to plane, amphithecia rugose and dactylose, spores 12,5-16x7-10 μ m, episporio about 1,3 μ m wide; pycnidia submarginate, infrequent, conidia sublageniform or weakly bifusiform, 5-7,5 μ m long.

Chemistry: cortex K+ yellow, medulla negative with all reagents; atranorin, caperatic acid and unidentified aliphatics acids present.

The name *dactylosum* has been given since the upper surface is covered by dactyls.

According to Estrabou and Adler (1998), *P. alidactylatum* is identical to *P. tsavoense*; however, the new species *P. dactylosum* basically differs from these two species by the shape and size of the conidia and the presence of caperatic acid and unknown aliphatic acids.

P. dactylosum superficially resembles *P. praesorediosum* since it has a small thallus and the medulla reacts negatively to the colour test; it is also similar to *P. tsavoense*, *P. alidactylatum*, *P. soredioaliphaticum* and *P. mordenii*, but the chemistry and the conidia are different.

Additional specimens examined: Brazil, Rio Grande do Sul, município Bagé, BR 153, km 193, secondary road, Casa de Pedra, on exposed rock in pasture field, 08.10.1988, *M. Fleig* 3305 (ICN 71179), top of hill, on rock, 03.11.1989, *M. Fleig* 3965 (ICN 72214); município Caçapava do Sul, secondary road, on rock in pasture field, 06.12.1993, *M. Fleig* 6027 (ICN 99191); município Esmeralda, Estação Ecológica de Aracuri, on exposed rock, 18.09.1982, *M. Fleig* 1675 (ICN 55005), 02.12.1984, *M. Fleig* 2466 (ICN 55885), 03.12.1984, *M. Fleig* 2475 (ICN 55894); município Lavras do Sul, Rincão do Inferno, on exposed rock in pasture field, 07.12.1993, *M. Fleig* 6045 (ICN 99209); município Porto Alegre, Morro Santana, on rock, 23.06.1982, *M. Fleig* 1606 (ICN 54902), Morro da Glória, on rock, 12.09.1982, *M. Fleig* 1624a (ICN 54953); município Santana do Livramento, Cerro Palomas, on exposed rock, 04.11.1995, *M. Fleig* 7185 (ICN 100402); município Terra de Areia, Serra do Pinto, Arroio do Carvalho, on exposed rock in pasture field, 29.04.1994, *M. Fleig* 6324 (ICN 99512); município Viamão, Itapuã, near Morro da Grota, on exposed rock, 26.09.1992, *M. Fleig* 4475 (ICN 73621), 4504 (ICN 73635).

***Parmotrema dissimile* Fleig, sp. nov.**

Fig. B

Thallus adnatus, saxicola, usque 10 cm diametro, glaucescens, lobis rotundatis, 4-7 mm latis, pro parte imbricatis, superne nitidus, emaculatus, deinde rugoso-dactylosus, centrum versus rimosus, dense dactylosus, dactyliis subramosis, sorediis et ciliis destitutus; medula alba; subtus niger, sparse rhizinosus, ambitus castaneus, papillosum, anguste nudus, opacus vel subnitidus; apothecia rara, urceolata, imperforata, 3-5 mm diametro, subpedicellata, amphithecia rugosa, sporae 13-17x6-7,5 µm, episporio 1,2 µm crasso; pycnidia rara, conidia sublageniformia, circa 6 µm longa. Atranorinum, norlobaridinum et acidum loxodicum continente.

Type: BRAZIL, Paraná, município Ponta Grossa, distrito de Vila Velha, countryside, on exposed rock, 05.02.1994, *M. Fleig* 6209 (ICN 99419).

Thallus 5-10 cm diam., attached, saxicolous, membranaceous to subcoriaceous, light-grey, lobes 4-7 mm wide, apices subconcave, sinuous and ascending, border weakly crenate or entire, lateral margin undulate, ascending, imbricate and sometimes crowded, eciliate; upper surface immaculate, shiny, becoming opaque, rugose and dactylose, sometimes granular, esorediate; medulla white; lower surface black, margins narrow, brown, shiny, soon papillate and scattered rhizinous, rhizines short, stout;

apothecia rare, substipitate, suburceolate, about 7 mm diam., amphithecium rugose to dactylose, spores 13-17x6-7.5 μm , episporia 1.2 μm wide; pycnidia rare, conidia sublageniform, 6 μm long.

Chemistry: cortex K⁺ yellow, medulla K⁻, C⁻, KC⁺ lilac, P⁻, UV⁻; atranorin, norlobaridin and loxodic acid present.

The name *dissimile* has been given since it is morphologically similar to *P. dactylosum* and *P. tsavoense*, but dissimilar in its chemistry.

P. dissimile is very similar to *P. dactylosum* in terms of its saxicolous habit and having dactyls, but it has norlobaridin and loxodic acid in the medulla; it is also very close to *P. tsavoense* in its morphology, but the African species has filiform conidia and physodic and oxyphysodic acid in the medulla (Krog & Swinscow, 1981).

Additional specimen examined: Brazil, Paraná, município Ponta Grossa, distrito de Vila Velha, on exposed rock in pasture field, 05.02.1994, *M. Fleig* 6212 (ICN 99422).

Parmotrema horridum Fleig, *sp. nov.*
= *Parmotrema* sp. 2 (Fleig, 1997)

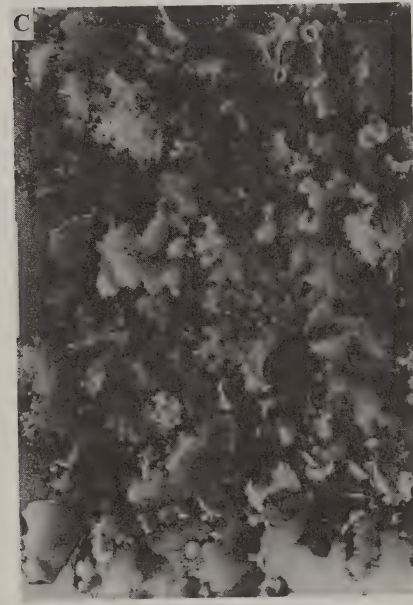
Fig. C

Thallus laxe adnatus, saxicola, viridi-glauescens, usque 15 cm latus aut latior, lobis rotundatis 4-8 mm latis, imbricatis aut undulatis subascendentibus, crenatis usque subintegris, cilia densa, 0.5-1.5 mm longa, superne opacus, laevigatus, emaculatus, centrum versus rugulosus, in aetate leviter rimosus, modice isidiatis, isidiis submarginalibus versus centrum densa, simplicibus, rare ramosis, ciliatis; medulla alba; subtus niger, sparse rhizinosus, ambitus castaneus, interdum sparse rhizinosus, anguste nudus, subnitidus, laevigatus; apothecia rara, versus centrum submarginalia, urceolata, imperforata, circa 4 mm diametro, brevi pedicellata, basi constricta, amphithecium isidiata-ciliata, sporae 14.5-19x9-12.5 μm , episporio 1 μm crasso; pycnidia rara, conidia cylindrica, 6-9 μm longa. Atranorinum et acidum olivetoricum continente.

Type: BRAZIL, Rio Grande do Sul, município Encruzilhada do Sul, distrito de Mina Velha, Fazenda Cerro da Árvore, on slanting rock in pasture field, 09.09.1995, *M. Fleig* 7075 (ICN 100290).

Thallus c. 15 cm or wider, loosely adnate, saxicolous, green-grey; lobes 4-8 mm wide, stretch or subascending, concave or subplanate on the apices, margin undulate, crenate, lateral margin undulate, ascending, subentire, densely ciliate, cilia sometimes

Figures A-D. A. *Parmotrema dactylosum* (M.Fleig 4486); B. *Parmotrema dissimile* (M.Fleig 6209); C. *Parmotrema horridum* (M.Fleig 7075); D. *Parmotrema praeisidiosum* (M.Fleig 6214). Scale = 1 cm.



cespitose, thin, 0,5-1,5 mm long; upper surface smooth, opace or brightish, immaculate, turning rugose and reticulate in the central area; isidia marginal and submarginal, laminar in the central areas, frequently granular and ciliate, to 0,5 mm tall; medulla white; under surface black at the center, brown and narrow marginal area, rarely white variegate, sublustrous; scattered groups of rhizines simple or branched, thin, 1-1,5 mm long; apothecia rare, laminar, imperforate, urceolate, substipitate, about 4 mm diam., base constricted, amphithecia isidiate, ciliate, spores 14,5-19x9-12,5 μm , episporia 1 μm wide; pycnidia rare, conidia baciliform, 6-9 μm long.

Chemistry: cortex K+ yellow; medulla K-, C+ salmon, KC+ reddish, P-, UV-; atranorin and olivetoric acid present.

The name *horridum* has been given in view of the density of the cilia, particularly on the margins and isidia.

This species appears to be related to *P. mellissii* since it often develops ciliated isidia and the lobes are densely ciliate, but *P. horridum* is a saxicolous species and has olivetoric acid in the medulla. *P. horridum* is found in similar areas to *P. vainioi*, but the former grows on exposed rocks (see Fleig, 1997), it also differs in terms of the isidia and the chemistry. *P. abnuens* (Nyl.) Hale (Hale, 1965) has the same chemistry, but has no isidia and is a corticolous species.

Additional specimens examined: Brazil, Rio Grande do Sul, município Encruzilhada do Sul, Passo dos Coqueiros, Cerro dos Mouros, Fazenda Xafri, on rock in scrubland, 08.09.1995, *M. Fleig* 7024 (ICN 100236), 7042 (ICN 100256), distrito de Mina Velha, Fazenda Cerro da Árvore, on sloping exposed rock, 09.09.1995, *M. Fleig* 7070 (ICN 100285); município São José dos Ausentes, Serra da Rocinha, sloping hill, on exposed rock in pasture field, 10.12.1994, *M. Fleig* 6674 (ICN 99869), 6677 (ICN 99872).

***Parmotrema praeisidiosum* Fleig, sp. nov.**

Fig. D

Thallus adnatus, saxicola, glaucescens, usque 10 cm diametro, lobis rotundatis, circa 5 mm latis, pro parte imbricatis, superne opacus, emaculatus, dense isidiatus, isidiis tenuis, simplicibus aut ramosis, ciliis et sorediis destitutus; medula alba; subtus niger, sparse rhizinosus, ambitus castaneus, papillosus, anguste nudus, opacus, laevigatus; apothecia rara, urceolata, 1-5 mm diametro, brevi pedicellata, amphithecia dense isidiata, sporae 13,5-17x6,5-7,5 μm , pycnidii destitutus. Atranorinum et acidum aliphaticum continente.

Type: BRAZIL, Paraná, município Ponta Grossa, distrito de Vila Velha, on exposed rock in pasture field, 05.02.1994, *M. Fleig* 6214 (ICN 99424).

Thallus 5-10 cm diam., adnate, saxicolous, membranaceous, light-grey; lobes 4-8 mm wide, margins plane to subconcave, subundulate, border smooth or irregular incised, involute, lateral margins subundulate, imbricate, eciliate; upper surface immaculate, even distal zone, soon becoming isidiate, isidia laminar, dense to the centre, at first to 0,5 mm tall, often ramous and becoming broad to 0,2 mm wide and

crowded; medulla white; lower surface black at the center, brown at the narrow shiny marginal zone, rhizines scattered, simple or weakly branched, stout; apothecia scattered, stipitate, to 2 mm diam., suburceolate, amphithecium isidiose, spores 13,5-17x6,5-7,5 µm; pycnidia not seen.

Chemistry: cortex K+ yellow, medulla negative with all reagents; atranorin and aliphatic acids present.

The name *praeisidiosum* is given because of its chemical similarity to *P. praesorediosum*.

P. praeisidiosum is close to *P. peralbidum* and *P. internexum* (Nyl.) Fleig (Fleig, 1997) in terms of its thallus and isidia morphology, but it has a small thallus and has aliphatic acids as *P. praesorediosum*.

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I wish also thank Prof. Pe. Clemente Steffen, S.J., Universidade do Vale dos Sinos, São Leopoldo, RS, for the latin text revision and Prof. Mark R.D. Seaward, University of Bradford, England, for a revision of the text.

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THREE NEW GENERA OF SMUT FUNGI

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ABSTRACT

New genera proposed: *Farysporium* K. Vánky, type *F. endotrichum* (Berk.) K. Vánky, on *Gahnia* (Cyperaceae); *Pseudodermatosorus* K. Vánky, type *P. alismatis-oligococci* (K. Vánky) K. Vánky, on *Alisma* and *Limnophyton* (Alismataceae); and *Pseudotracya* K. Vánky, type on *Ottelia* (Hydrocharitaceae). **New species** proposed: *Pseudotracya otteliae* K. Vánky, type on *Ottelia ovalifolia*, Australia). **New combinations** proposed: *Farysporium endotrichum* (Berk.) K. Vánky, based on *Ustilago endotricha* (type on *Gahnia* sp., New Zealand); *Pseudodermatosorus alismatis-oligococci* (K. Vánky) K. Vánky, based on *Doassansia alismatis-oligococci* (type on *Alisma oligococcum*, Sri Lanka); and *P. sagittariae* (K. & C. Vánky) K. Vánky, based on *Burrillia sagittariae* (type on *Sagittaria planitiana*, Venezuela).

Key words: smut fungi, *Farysporium*, *Pseudodermatosorus*, *Pseudotracya*

INTRODUCTION

Berkeley (in Hooker, 1855:196) described a smut fungus under the name of *Ustilago endotricha* Berk. "on the peduncles of the panicles of *Gahnia*" from New Zealand, collected by A. Sinclair during the Antarctic Voyage in the years 1839–1843, with J. D. Hooker as assistant surgeon and botanist of the expedition.

Because of the presence of long, coloured "elaters" in the sori, Cunningham (1924:416) transferred the name into the genus *Elateromyces* Bubák (1912:32; type *E. olivaceus* (DC.) Bubák, on *Carex riparia* Curtis, France), as *E. endotrichus* (Berk.) Cunn. *Elateromyces* is synonymous to the earlier described *Farysia* Raciborski (1909:354; type *F. javanica* Racib., on *Carex* sp., Java), therefore, H. & P. Sydow (1919:41) transferred the name into this genus as *F. endotricha* (Berk.) H. & P. Sydow. However, the *Gahnia* smut shows several characters which differentiate it from the c. 20 known *Farysia* species (all in the gynoeceum of *Carex* species), and from other known genera of smut fungi (comp. also Vánky, 1987), thus requiring the erection of a separate genus for it.

Farysporium K. Vánky, gen. nov.

Sori pedicellos, pedunculos et axes principales inflorescentiae Cyperacearum circumdantes, massas agglutinatas usque granulares vel granulari-pulvereas glomerulorum sporarum formantes intermixtas cum fasciculis hypharum sterilium capillitium-formibus ("elaterae"). *Sporae* in glomerulis laxis, pigmentiferae. *Sporae* et fasciculi hypharum sterilium e stromate fungali in superficie telarum matricis disposito sese evolventes. *Sori* sine columellis. *Cellulae steriles* nullae inter glomerulos et in glomerulis sporarum. *Germinatio sporarum* cum basidiis septatis vel filamentis longis. *Hyphae* parasiticae intracellulares. *Septa* matura sine poris.

Sori surrounding the pedicels, peduncles and main axes of the inflorescence of Cyperaceae forming black, agglutinated to granular or granular-powdery masses of spore balls intermixed with capillitium-like fascicles of sterile hyphae ("elaters"). Spores in loose spore balls, pigmented. Spores and fascicles of sterile hyphae differentiate from a fungal stroma on the surface of the host tissues. No columellae in the sori. Sterile cells between or within the spore balls are lacking. Spore germination results in either septate basidia or in long filaments. Parasitic hyphae are intracellular. Mature septa are poreless. Typus generis:

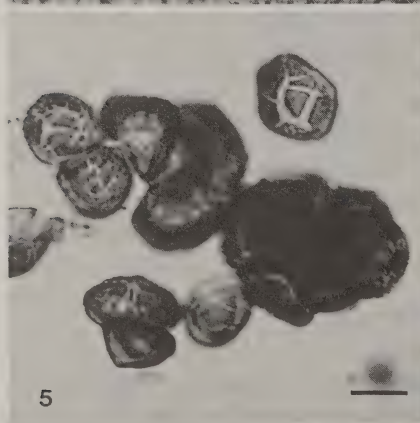
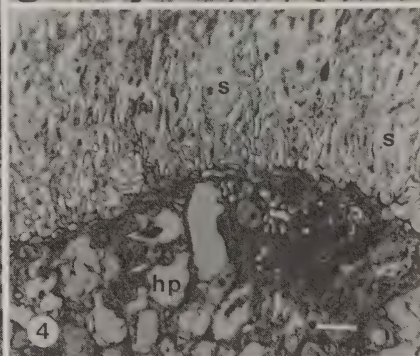
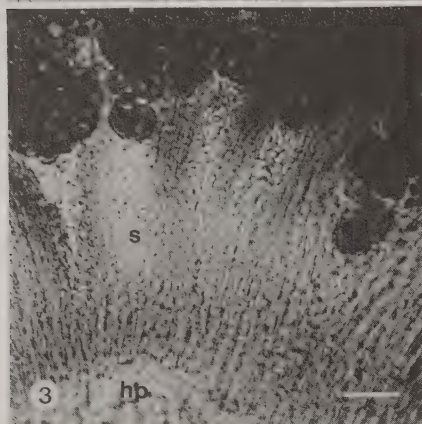
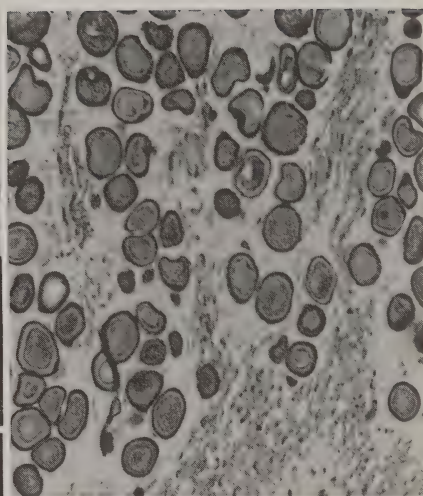
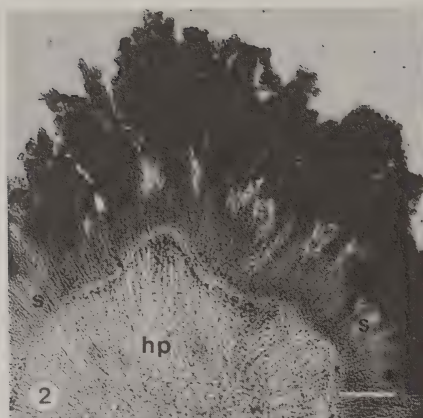
Farysporium endotrichum (Berkeley) K. Vánky, comb. nov.

Basionym: *Ustilago endotricha* Berkeley, in Hooker, The botany of the Antarctic Voyage. II. Flora Novae-Zelandiae. Part II. Flowerless plants. London. 1855:196. — *Elateromyces endotrichus* (Berkeley) Cunningham, 1924:416. — *Farysia endotricha* (Berkeley) H. & P. Sydow, 1919:41. — Type on *Gahnia* sp., New Zealand, Auckland, coll. A. Sinclair (K).

Sori (Figs. 1–4) surrounding the pedicels, peduncles and main axes of the inflorescence (sometimes only partly), fusiform, ellipsoidal or globoid, 0.3–1(–2) x 0.5–4(–7) cm, black or blackish-brown, composed of compact spore masses with powdery surface, traversed by numerous, radially arranged fascicles of fungal filaments ("elaters"), extending beyond the spore masses. Peridium on the surface of young sori was not observed. At maturity, the spore masses break into small pieces composed of agglutinated spore balls. *Spore balls* (Figs. 5, 6) ellipsoidal or irregular, 20–50 µm long, dark olivaceous- or chestnut-brown, composed of (2–)3–15(–20 or more?) easily separating spores. *Spores* (Figs. 5, 6) globose, subglobose, ellipsoidal, pyriform or irregular, (11–)12–17 x 13–19 µm, olivaceous- to chestnut-brown; wall (1.5–)2–3 µm thick including the typically cracked (scaly) exospore, sometimes with a short, hyaline papilla at one end. Parasitic hyphae intracellular. Mature septa poreless (Dr. R. Bauer, pers. comm.). Spore formation (Figs. 2–4) at the basal part of the sori in radially arranged sporogenous hyphae. Very young spores are catenulate, fusiform, yellow, thick-walled, smooth. With maturation the spores become larger, ellipsoidal, globose, pigmented, with cracked exospore, agglutinated in balls and often have one or several, slightly flattened sides. *Capillitium*-like fungal filaments ("elaters") between the spore masses arise from the basal stroma, are 10–50 µm wide, up to 15 mm long, yellowish- to dark olivaceous-brown, composed of numerous,



Fig. 1. Sori of *Farysporium endotrichum* (Berk.) K. Vánky on *Gahnia procera* J. R. & G. Forst, New Zealand, Stewart Island, Ulva Island, 10.II.1998, E. H. C. McKenzie, C. & K. Vánky (HUV 18722). Bar = 1 cm.



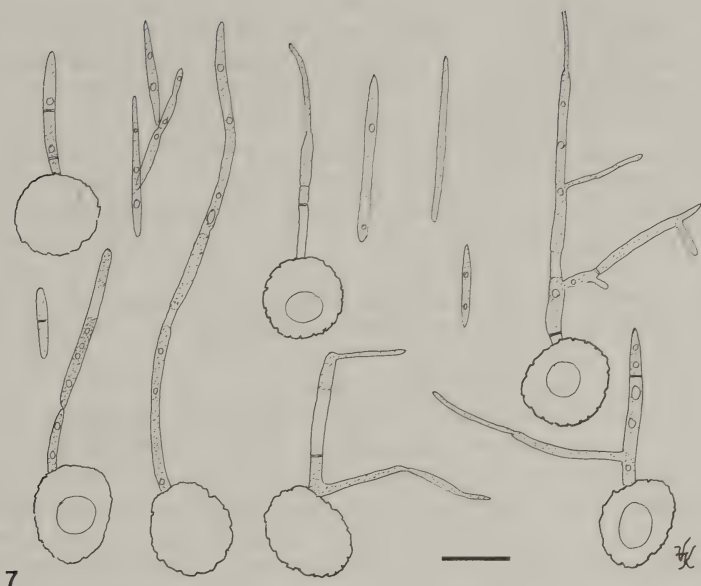


Fig. 7. Spore germination of *Farysporium endotrichum* (Berk.) K. Vánky from *Gahnia setifolia* (A. Rich.) Hooker fil. (in water, at room temp., after 5 days). New Zealand, 7.II.1990 (HUV 14950). Bar = 10 μ m.

Figs. 2–6. *Farysporium endotrichum* (Berk.) K. Vánky on *Gahnia procera* J. R. & G. Forst., New Zealand, South Island, Arthur's Pass National Park, 15.XII.1980, leg. L. Tibell (HUV 10573).

Figs. 2, 3, 4. Transverse section of a part of a sorus, with host plant tissues (hp) from which a fungal stroma (s) arises of which spore balls and strands of sterile hyphae (capillitia) develop.

Bars = 100 μ m, 25 μ m, and 10 μ m, respectively.

Figs. 5, 6. Spore balls and spores, with typically cracked surface, in LM and in SEM. In SEM picture also a part of a capillitium is seen. Bar = 10 μ m.

agglutinated, elongated, transversally septate, 1.5–2.5 μm wide hyphae, apparently without cell content. *Spore germination* (Fig. 7; of freshly collected spores, in water, at room temp., after 5 days) resulted in either septate basidia or in long filaments. The basidia give rise to hyphae or to shorter or longer, fusiform basidiospores which separate easily (Vánky, 1997a:153).

On Cyperaceae: *Gahnia* species, Australasia: *G. grandis* (Labill.) S. T. Blake (Australia, Tasmania), *G. pauciflora* T. Kirk (NZ), *G. procera* J. R. & G. Forst. (NZ), *G. setifolia* (A. Rich.) Hooker fil. (NZ), *G. xanthocarpa* (Hooker fil.) Hooker fil. (NZ), and *G. sp.* (NZ).

Etymology: *Farysporium* is a combination of *Fary-* from *Farysia* and *-sporium*, the suffix of many spore-ball forming genera of smut fungi.

DISCUSSION

Because of the presence of fascicles of sterile hyphae ("elaters") between the spore masses, it was generally accepted since H. & P. Sydow (1919:41) that *Ustilago endotricha* belongs to the genus *Farysia*. However, i.e., the following characters differentiate this species and the genus *Farysporium* from *Farysia*. All known species (c. 20) of *Farysia* are restricted to *Carex* species producing their sori exclusively in the gynoeceum, within the utricles, starting from the swollen floral pedicel or from the ovaries. [*"Farysia" trichopterygis* (Masse) Zundel, on *Trichopteryx hordeiformis* Stapf, Poaceae, was excluded from this genus (Vánky, 1997b:161), belonging to the Fungi Imperfecti]. Sori of *Farysia* when young are covered by a thick peridium which is lacking in *Farysporium*. The spore masses in *Farysia* are pale or dark olivaceous-brown (not black), powdery (not agglutinated), the spores are much smaller than those of *Farysporium* (usually less than 6 μm in width and 12 μm in length), and the spore wall is thin provided with fine verrucae. Spores of *Farysia* species are single, never forming spore balls.

TWO NEW GENERA OF DOASSANSIALES

The "*Doassansia*" group represents an interesting assemblage of smut fungi which all are adapted to aquatic or paludal plants belonging to widely different genera. They produce pale coloured spores agglutinated in spore balls (except *Doassinga*) embedded in the host tissues. The spore balls are composed of spores, sterile cells and/or hyphae in various arrangements. The arrangement of these components and the structure of the spore balls is used for their generic delimitation. Gradually nine genera have been recognised: 1. *Burrillia* Setchell (1891:18), 2. *Doassansia* Cornu (1883:285), 3. *Doassansiopsis* (Setchell) Dietel (in Engler & Prantl, 1897:16), 4. *Doassinga* K. Vánky, R. Bauer & Begerow (1998:965), 5. *Heterodoassansia* K. Vánky (1993:28), 6. *Nannfeldtiomyces* K. Vánky (1981:171), 7. *Narasimhanian* Thirumalachar & Pavgi (1952:390), 8. *Pseudodoassansia* (Setchell) K. Vánky (1981:174), and 9. *Tracya* H. & P. Sydow (1901:3)).

Until recently it was thought that the "*Doassansia*" group represents a morphologically, ecologically and phylogenetically natural group. However, ultrastructural studies (Bauer et al., 1997), and molecular analyses (Begerow et al., 1997) demonstrated that the studied members of the genus *Doassansiopsis* are not related to members of the other genera. This means that similar spore ball structures, adapted to aquatic or paludal plants and environment, developed from different ancestors by convergent evolution. In the new, phylogenetical system, *Doassansiopsis* belongs to the Doassansiopsaceae Begerow, R. Bauer & Oberw., within the order Urocystales R. Bauer & Oberw. of the subclass Ustilaginomycetidae Jülich, emend R. Bauer & Oberw. All other genera of the "*Doassansia*" group are classified into the Doassansiaceae (Azbukina & Karatygin) R. T. Moore, emend R. Bauer & Oberw. within the order Doassansiales R. Bauer & Oberw. of the subclass Exobasidiomycetidae Jülich, emend R. Bauer & Oberw. The fact that all studied species of *Doassansiopsis* (and no species from other genera) belong to a different subclass, demonstrates also the significance of the structure of the spore balls in the classification of this group of smut fungi.

Ultrastructural and molecular studies demonstrated that not necessarily all members of the Doassansiaceae form spore balls, e.g., "*Entyloma*" *callitrichis* Liro, producing single spores in the leaves of *Callitriche* species, also belongs to the Doassansiaceae. For this smut a new genus, *Doassinga* K. Vánky, R. Bauer & Begerow (1998), was proposed.

Studies of spore ball structures of aquatic smut fungi revealed two additional types of spore balls. For these smuts two new genera are proposed.

In 1975, I described an unusual *Doassansia* species, collected in Sri Lanka, *D. alismatis-oligococci* K. Vánky (1975:45), forming spore balls in the leaves of *Alisma oligococcum* Mueller. The unusual feature of this species was that the spores within the spore balls are embedded in a very fine network of sterile fungal cells. Now, that I have more experience with this group of smut fungi, I consider that this character is a generic differentiating character from *Doassansia* in which this network is missing.

***Pseudodermatosorus* K. Vánky, gen. nov.**

Sori in foliis plantarum aquaticarum vel palustrum sicut maculae flavido-brunneae cum glomerulis sporarum in telis matricis inclusis. *Glomeruli sporarum* permanentes, compositi e cortice cellularum sterilium et e massa centrali sporarum debiliter pigmentiferarum in reticulo e cellulis sterilibus formato inclusarum.

Sori in the leaves of aquatic or paludal plants as yellowish-brown spots with spore balls embedded in the host tissues. *Spore balls* permanent, composed of a cortex of sterile cells and a central mass of poorly pigmented spores embedded in a network of sterile fungal cells. *Typus generis*:



Fig. 8. Sori of *Pseudodermatosorus alismatis-oligococci* (K. Vánky) K. Vánky on the leaves of *Alisma oligococcum* Mueller (type). Bar = 1 cm.

***Pseudodermatosorus alismatis-oligococci* (K. Vánky) K. Vánky, comb. nov.**

Basionym: *Doassansia alismatis-oligococci* K. Vánky, Svensk Bot. Tidskr. 69:45, 1975. — Type on *Alisma oligococcum* Mueller (*A. glandulosum* Thw.), Sri Lanka, Yala National Park, 6°20' N, 81°31' E, alt. c. 15 m, 12.III.1974, leg. K. Vánky. Holotype in S, isotypes in HUV (472), IMI (190442), UPS, and in Vánky, Ust. exs. No. 176 (as *Doassansia alismatis-oligococci*).

Sori (Fig. 8) in the leaves, forming at first pale yellow, later brown, small, scattered or grouped, circular, amphigenous spots or pustules, 1–4(–5) mm in diam., with subepidermal spore balls visible as minute, brown, punctate elevations or pustules when numerous and grouped. *Spore balls* (Fig. 10) permanent, globose, ovoid, elongate or irregular, 100–230 x 150–300 µm, light brown, each composed of a cortical layer of sterile cells and a core of numerous spores embedded in a very fine, subhyaline network of sterile fungal cells. *Cortical sterile cells* (Figs. 10, 11) in one layer, radially elongated, in surface view very variable in shape and size, rounded, elongated, polygonal, 4–18 x 6–22 µm, in lateral view subquadrangular to subtriangular, firmly adhering to each other, 7–20 x 10.5–36 µm, pale yellowish-brown or subhyaline; wall 0.8–1.5 µm thick, smooth. *Spores* (Figs. 10, 12) more or less globose, ovoid, rarely slightly irregular, 9.5–13.5 x 10.5–17.5 µm, pale yellowish-brown or subhyaline; wall c. 0.8 µm thick, smooth. The space between the spores varies between 0–12(–16) µm and is filled with a very fine, subhyaline network of sterile fungal cells. In young spore balls the spores differentiate first while the cortical sterile cells are still rudimentary, thin-walled, more or less isodiametric and surrounded by a thick layer of mycelium (Fig. 13).

On Alismataceae: *Alisma oligococcum* Mueller (*A. glandulosum* Thw.), Sri Lanka, and *Limnophyton obtusifolium* (L.) Miq., Rep. of South Africa.

Etymology: *Pseudodermatosorus* from the Greek *pseudo* = false, apparent, imitation, i.e., resembling but not equalling, and *Dermatosorus*, because of the resemblance of the spore ball structure in these two genera.

A further smut fungus possessing a *Pseudodermatosorus*-like spore ball structure is "*Burrillia*" *sagittariae* K. & C. Vánky. In this species the spore balls possess a cortical layer of sterile cells which is absent in *Burrillia* (Pl. I. fig. 1). Therefore, it is better to place it into this new genus as:

***Pseudodermatosorus sagittariae* (K. & C. Vánky) K. Vánky, comb. nov.**

Basionym: *Burrillia sagittariae* K. & C. Vánky, in Vánky, Mycotaxon 59:90, 1996. — Type on *Sagittaria planitiana* Agostini (Alismataceae), Venezuela, Estado Guarico, 70 km N. of San Fernando, 8°28' N, 67°35' W, alt. c. 100 m, 7.XII.1993, coll. R. Berndt, C. & K. Vánky. Holotype in Herb. Ustil. Vánky (HUV 16004!), isotypi in BPI and in Vánky, Ust. exs. No. 1003 (as *Burrillia sagittariae*).

For a full description and illustration see Vánky, Mycotaxon 59:90–93, 1996 (as *Burrillia sagittariae*).

Pseudodermatosorus (Pl. I. fig. 8) differs from *Doassansia* (Pl. I. fig. 2) in having spore balls in which the spores are scattered in a network of sterile fungal cells. Such a network is absent in *Doassansia*. The spore ball structure of *Pseudodermatosorus* resembles that of *Dermatosorus* Sawada ex Ling, in which there also is a cortex of sterile cells and a central mass of spores embedded in a parenchymatous tissue of minute sterile fungal cells. However, *Pseudodermatosorus* and *Dermatosorus* are not related to each other. Spore germination in *Dermatosorus* results in phragmobasidia, whereas in members of the Doassansiaceae spore germination results in holobasidia. The sori of the five known species of *Dermatosorus* are produced in the ovaries of Cyperaceae and have a different structure (see Vánky, 1987:29 & 1995:215-218). In the recently proposed classification of the smut fungi (Bauer et al., 1999, Vánky, 1999), *Dermatosorus* belongs to the subclass Ustilaginomycetidae Jülich, emend R. Bauer & Oberw., order Ustilaginales G. P. Clinton, emend R. Bauer & Oberw., family Ustilaginaceae L.-R. & C. Tul., emend R. Bauer & Oberw. The Doassansiaceae, to which *Pseudodermatosorus* most probably belongs, are classified into the subclass Exobasidiomycetidae Jülich, emend R. Bauer & Oberw., order Doassansiales R. Bauer & Oberw.

Between unidentified Australian smut fungi, a spore-ball-forming species was found in the leaves of *Ottelia ovalifolia* (R. Br.) Rich. (Hydrocharitaceae), in which the spore ball structure resembles that of *Tracya* (Pl. I. fig. 11) with the exception that the spore balls with a cortical layer of spores, are filled with a parenchymatous fungal tissue, not with hyphae as in species of *Tracya*. For it a new genus is proposed:

***Pseudotracya* K. Vánky, gen. nov.**

Pseudotracya a *Tracya* H. et P. Sydow (Hedwigia, Beibl. 40:(3), 1901) distincta propter structuram glomerulorum sporarum. In *Pseudotracya* glomeruli sporarum telis fungalibus paranchymaticis repleti, sed in *Tracya* illi repleti cum reticulo hypharum ramosarum, septatarum, induratarum.

Pseudotracya differs from *Tracya* H. & P. Sydow (Hedwigia, Beibl. 40:(3), 1901), in the structure of the spore balls. In *Pseudotracya* the spore balls are filled with a parenchymatous fungal tissue, whereas in *Tracya* they are filled with a network of branched, septate, hardened hyphae (Pl. I. figs. 10, 11). Typus generis:

***Pseudotracya otteliae* K. Vánky, sp. nov.**

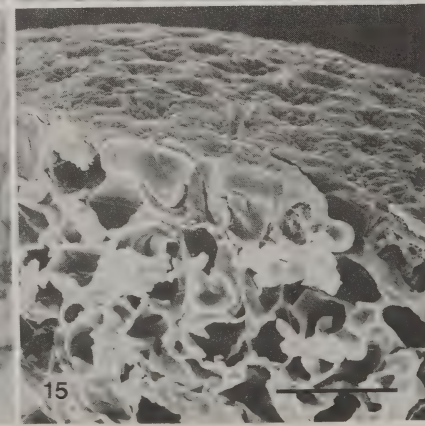
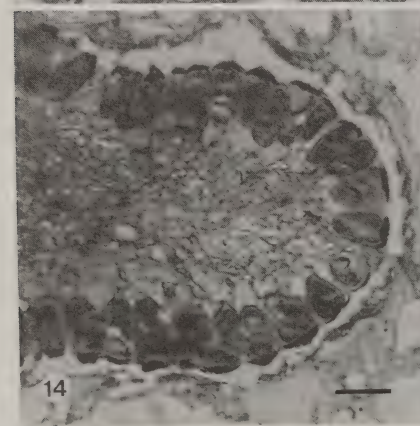
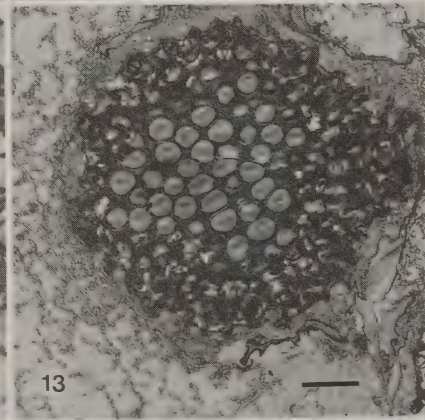
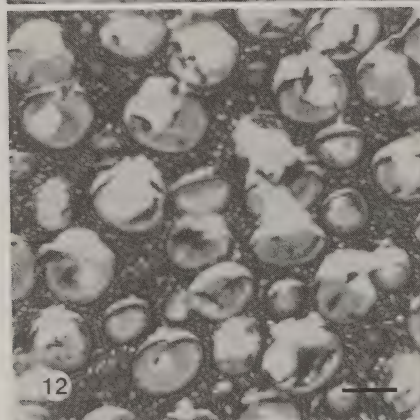
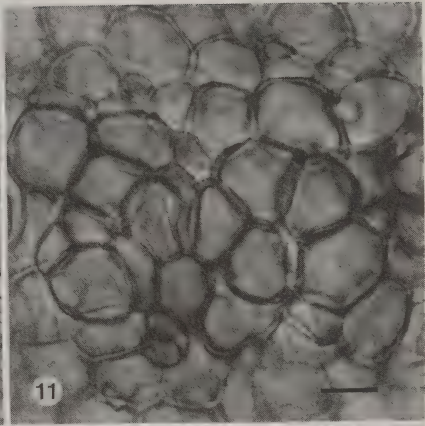
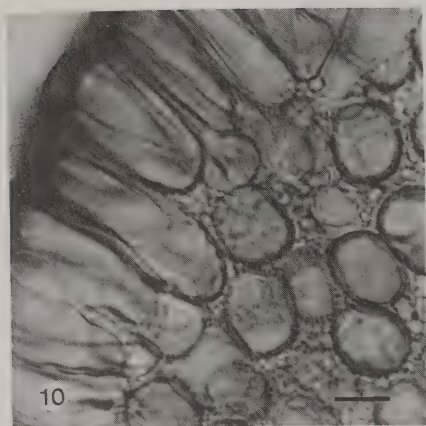
Typus in matrice *Ottelia ovalifolia* (R. Br.) Rich. (Hydrocharitaceae), Australia, Queensland, c. 100 miles W. Rockhampton, Blackdown Tableland, Stony Creek, 3.IX.1974, leg. A. B. Cribb. — Holotypus in BRIP 8026!, isotypi in BRIU 2502 et in Herbario Ustil. Vánky (HUV 18534!).

Sori in foliis, maculas indefinitas flavas usque flavido-brunneas, diametro 2–10 mm, cum glomerulis sporarum in telis matricis inclusis sicut punctis minutis, brunneis, parum elevatis. *Sori* vetusti saepe perforati propter destructionem telarum matricis. *Glomeruli sporarum* persistentes, globosi,



Fig. 9. Sori of *Pseudotrachya otteliae* K. Vánky in the leaves of *Ottelia ovalifolia* (R. Br.) Rich. (type). Bar = 1 cm.

ovoidei, elongati, 80–170 x 110–220(–270) μm , pallide brunnei, compositi e strato corticali sporarum firmiter cohaerentium et e massa centrali telarum fungalium parenchymatosa. *Sporae* visu superficiali polyangulariter irregulares, (5–)6–9,5 x (5–)6–12 μm , verrucosae, visu laterali subquadrangulares, vel radialiter elongatae, subtetragonales, raro subtriangulares, 4–9 x 10–13 μm , pallide flavido-brunneae; pariete partis externae, liberae verrucoso, 1,5–2,5 μm crasso, parietibus contactis et internis tenuibus (cca. 0,5 μm), levibus. *Massa centralis* telae parenchymaticae e cellulis vacuis, forma et magnitudine valde variabilibus, 2,5–8 x 5–15 μm , pallide flavidobrunneis composita; pariete tenui (cca. 0,4 μm), levi.



Sori (Fig. 9) in the leaves forming yellow to yellowish-brown, indefinite spots, 2–10 mm in diameter, with spore balls embedded in the host tissue appearing as minute, brown, slightly elevated dots. Old sori are often perforated due to destroyed host tissues. *Spore balls* (Fig. 14; Pl. I. fig. 10) persistent, globose, ovoid, elongate, 80–170 x 110–220(–270) μm , light brown, composed of a cortical layer of firmly adhering spores and a central mass of parenchymatous fungal tissue. *Spores* (Figs. 14, 15) in surface view polyangularly irregular, (5–)6–9.5 x (5–)6–12 μm , verrucose, in lateral view subquadrangular or radially elongated, subtetragonal, rarely subtriangular, 4–9 x 10–13 μm , pale yellowish-brown; outer, free, verrucose wall 1.5–2.5 μm thick, contact and inner walls thin (c. 0.5 μm), smooth. *Central mass* (Fig. 14) of parenchymatous tissue composed of empty cells, extremely variable in shape and size, 2.5–8 x 5–15 μm , pale yellowish-brown; wall thin (c. 0.4 μm), smooth.

On Hydrocharitaceae: *Ottelia ovalifolia* (R. Br.) Rich.; Australia. Known only from the type collection.

Etymology: *Pseudotracya* from the Greek *pseudo* = false, apparent, imitation, and *Tracya*, because of the similarities of these two genera.

Figs. 10–11. *Pseudodermatosorus alismatis-oligococci* (K. Vánky) K. Vánky on *Alisma oligococcum* Mueller (type). Hand-sectioned spore balls.

Fig. 10. Part of a spore ball with elongated, empty cortical cells, and subglobose to ellipsoidal, thin-walled spores scattered in a very fine network of fungal cells.

Fig. 11. Cortical, sterile cells seen in surface view. Bars = 10 μm .

Figs. 12–13. *Pseudodermatosorus alismatis-oligococci* (K. Vánky) K. Vánky on *Limnophyton obtusifolium* (L.) Miq. (Rep. of South Africa, Transvaal Prov., Pilgrimsrest Distr., Kruger National Park, Leeupan, V.1964, coll. H. C. Taylor; HUV 18509 ex PRE 5776). Embedded, sectioned and coloured spore balls.

Fig. 12. Central part of a spore ball with spores and between them the fine network of small, sterile fungal cells.

Fig. 13. Developing spore ball with central mass of young spores, an undeveloped cortex and around the spore ball a layer of mycelium.

Bars = 10 and 25 μm , respectively.

Figs. 14–15. *Pseudotracya otteliae* K. Vánky on *Ottelia ovalifolia* (R. Br.) Rich. (type). Sectioned spore balls in LM and in SEM showing the single layer of peripheral, tightly adhering spores with verrucae on their free surface, and the empty cells of parenchymatous fungal tissue filling the spore balls.

Bars = 10 μm .

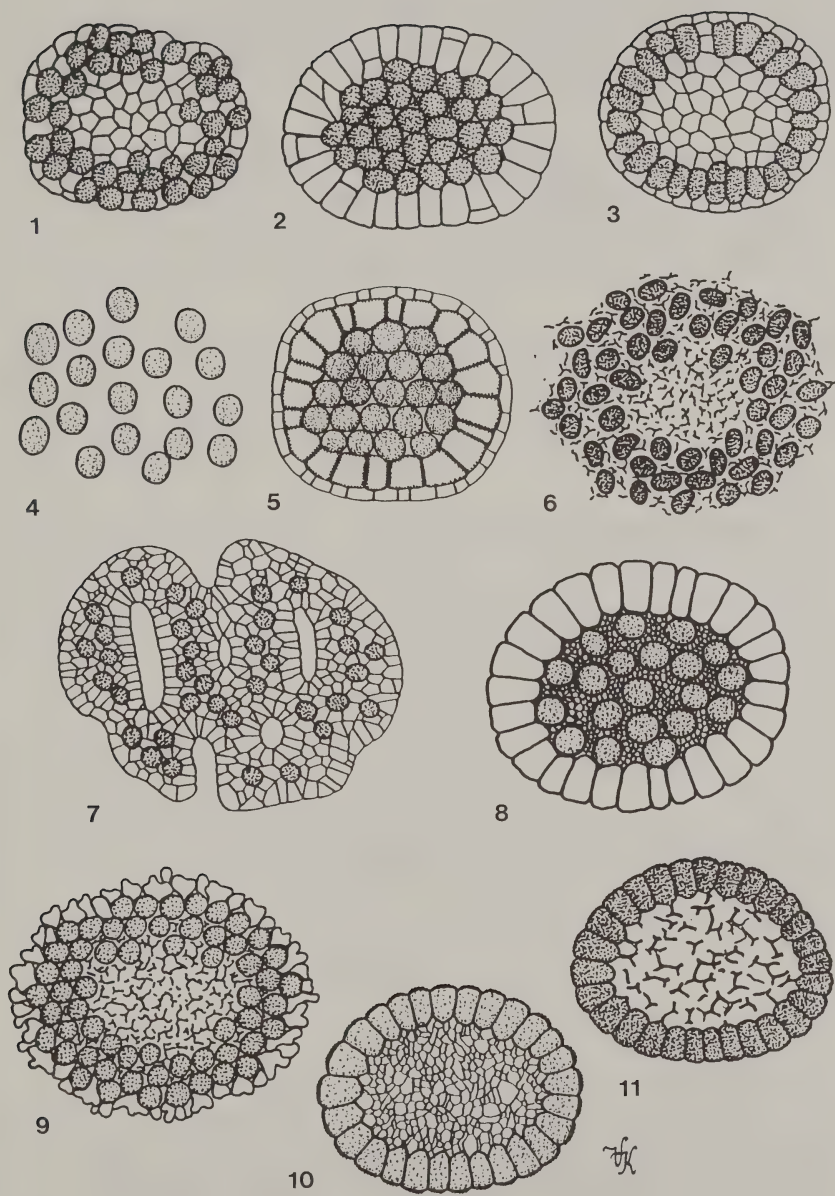
**Key to the genera of smut fungi forming pale coloured spore balls,
exceptionally single spores, in the host tissues of aquatic or paludal plants**

1. Spores single, not in balls *Doassinga*
 - Spores in loose or permanent spore balls 2
2. Spore balls without cortex 3
 - Spore balls with cortex 4
3. Spore balls loose, friable, consisting of branched hyphae in which the spores are scattered..... *Nannfeldtiomyces*
 - Spore balls persistent, consisting of parenchymatous fungal tissue of sterile cells in which the spores are scattered..... *Burrillia*
4. Cortex of firmly united spores 5
 - Cortex of sterile cells..... 6
5. Central part of the spore balls consisting of a network of branched hyphae *Tracya*
 - Central part of the spore balls consisting of parenchymatous fungal tissue *Pseudotracya*
6. Spore balls lobed and also containing cavities *Narasimhania*
 - Spore balls not lobed, compact, without cavities..... 7
7. Central part of the spore balls composed of hyphae; spores situated between these and the cortex *Pseudodoassansia*
 - Central part of the spore balls not composed of hyphae 8
8. Central part of the spore balls composed only of parenchymatous sterile cells; spores situated between these and the cortex..... *Doassansiopsis*
 - Central part of the spore balls composed of spores or also of sterile cells 9
9. Central part of the spore balls composed only of spores..... 10
 - Central part of the spore balls composed of spores scattered in a network of sterile fungal cells..... *Pseudodermatosorus*
10. Cortical cells of one kind, not ornamented *Doassansia*
 - Cortical cells of two kinds: external, small, not ornamented, and internal larger, ornamented on their inner surface..... *Heterodoassansia*

Pl. I.

Smut fungus genera forming pale coloured spore balls (exceptionally single spores), in the host tissues of aquatic or paludal plants ("*Doassansia*" group). Somewhat schematically illustrated.

1. *Burrillia* Setchell, 2. *Doassansia* Cornu, 3. *Doassansiopsis* (Setchell) Dietel, 4. *Doassinga* K. Vánky, R. Bauer & Begerow, 5. *Heterodoassansia* K. Vánky, 6. *Nannfeldtiomyces* K. Vánky, 7. *Narasimhania* Thirumalachar & Pavgi, 8. *Pseudodermatosorus* K. Vánky, 9. *Pseudodoassansia* (Setchell) K. Vánky, 10. *Pseudotracya* K. Vánky, 11. *Tracya* H. & P. Sydow.



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COMPUTER IDENTIFICATION OF GILLED MUSHROOM GENERA OCCURRING IN CANADA

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SUMMARY

With the advent of powerful personal computers, it is now possible to compile and organize available taxonomic information in a readily accessible form. A computerized approach has been developed to identification of 136 genera of gilled mushrooms (Agaricales), and 5 genera of Aphyllophorales with mushroom-like members, known to occur in Canada. The database compiled for this purpose uses the DOS version of askSam, a user-friendly database management program that can be run on any IBM-compatible PC. The database file, AGARICS.ASK, can be probed in many ways, using Boolean searches, and so can be used as a computerized synoptic key in a tiered, menu-driven manner. This computerized key incorporates records of 1,981 distinct character states from all 141 genera, distributed among 78 menus. A glossary of mushroom terminology is also included. Since the database contains all available information (i.e. at the time of writing), and can be accessed at any point, (i.e., in a synoptic manner) it permits faster, more efficient, and more accurate identification to the generic level than any previous key.

INTRODUCTION

Field guides, containing colour photographs or paintings and brief descriptions of organisms within specific taxonomic groups, are modern examples of useful tools which help amateurs in the identification procedure. But the novice may find the use of these guides both time consuming and frustrating, because many pages of text and pictures usually have to be read and analysed before a specimen can be matched with an illustration. Even then, the identification may be incorrect, because it is difficult if not impossible for any field guide to incorporate illustrations that represent all possible appearances and stages of development of the organisms.

Traditionally, dichotomous keys were the standard type of systematic key

used for identification purposes (Kendrick, 1990). However, in practice it is frustrating for the beginner, and at times even for the professional, to use dichotomous keys. The problem is that in such keys there is typically only one route leading to the identity of an unknown (Rhoades, 1985). If the key uses ambiguous, rather than truly conservative, traits, misidentification may occur even if the proper route is taken. Many dichotomous keys to agarics fail to incorporate diagnostic microscopic features and are therefore very limited in their usefulness. For these reasons, very few experienced field mycologists use a dichotomous key for their determinations (Largent and Thiers, 1977). Despite this, many field guides still supply users with dichotomous keys, perhaps *faute de mieux*.

Fortunately, there is a better way, and it is called a synoptic key. Perhaps the strongest point of synoptic keys is that the user can enter the search at any point, and characters can be entered in any order — there is no prescribed sequence. Through repeated comparisons of all taxa in the key on the basis of each available trait, an unknown taxon can frequently be successfully identified by a process of elimination (Adaskaveg et al., 1994). The problems associated with synoptic keys include complications in compiling a large number of taxa, and the fact that not all can be competently identified (i.e. not all taxa have absolute definitions) (Adaskaveg et al., 1994). For manual synoptic keys to work well, the maximum number of taxa involved should not be greater than 30 (fide Korf, 1972), or 50 (fide Kendrick, 1990), or 60 (fide Rhoades, 1985). Unfortunately, many field guides and mycology books do not use synoptic keys, because (1) the number of taxa is too large to be dealt with by a manually operated synoptic key, and (2) most amateurs are unfamiliar with the technique of using such a key (which involves making lists and checking off matches at each step).

Fortunately, taxonomic data can now be assembled and organized with the aid of appropriate computer software. Despite this potential, very few computerized keys have yet been produced (Adaskaveg et al., 1994; Kendrick, 1990).

The aim of this study was to create a modified computerized approach to synoptic identification of genera of gilled agarics occurring in Canada using askSam (askSam Systems, P.O. Box 1428, Perry, FL 32347, U.S.A.), a user-friendly database management program. AskSam was chosen because it operates extremely quickly, is very versatile, and is easy to use. Data can be entered easily and in any chosen format within records/documents, and the way in which information is recovered can be varied (i.e., either by typing in keywords on a query line or by choosing (highlighting) menu options in hypertext). Another purpose of this paper is to explain that describing many character states in a natural way is more comprehensible than many of the traditional descriptive terms used in agaric taxonomy. Development of the computerized mushroom key also serendipitously permits re-examination of the generic concept among the gilled agarics (another objective of this study which will be discussed in a subsequent paper).

MATERIALS AND METHODS

Macroscopic and microscopic characteristics of 141 genera of gilled mushrooms and similar organisms known to occur in Canada were entered into

an askSam file. The genera represent 16 families and 2 orders within class Holobasidiomycetes of subdivision Basidiomycotina. The taxonomic information used to create the database was derived partly from the literature: Pomerleau (1951, 1980), Orton (1960), Smith (1963), Kauffman (1971a, b), Moser (1978), Smith et al. (1979), Arora (1986), Breitenbach and Kränzlin (1986, 1991), Singer (1986), Largent and Baroni (1988), Lincoff (1988), Minot (1989), Phillips (1991), and Kibby (1992); and partly from direct macroscopic and microscopic examination of hundreds of agaric specimens collected in Southern Ontario during spring, summer, and fall of 1992, 1993, and 1994.

Macroscopic examination entailed observation of morphology, surface texture, flesh consistency, colour, measurements, habitat, and habit of freshly collected basidiomata.

Microscopic examination involved preparation of squash mounts from different regions of the basidioma (i.e. pileus surface, pileus flesh, stipe surface, stipe flesh, and lamellae) on microscope slides. Squashes were mounted in water, 5% potassium hydroxide, Melzer's reagent, and cotton blue for the pileus and stipe regions. Squashes made from the lamellae were mounted in all of the above reagents and in acetocarmine.

The genera of mushrooms in the computer key are listed below under their family and order.

Order: Agaricales

- 1) Agaricaceae: *Agaricus*, *Melanophyllum*
- 2) Amanitaceae: *Amanita*, *Limacella*
- 3) Bolbitiaceae: *Agrocybe*, *Bolbitius*, *Conocybe*, *Gastrocybe* (sequestrate)
- 4) Coprinaceae: *Coprinus*, *Lacrimaria*, *Panaeolus*, *Psathyrella*
- 5) Cortinariaceae: *Alnicola*, *Cortinarius*, *Crepidotus*, *Dermocybe*, *Galerina*, *Gymnopilus*, *Hebeloma*, *Inocybe*, *Melanomphalia*, *Naucoria*, *Phaeocollybia*, *Phaeolepiota*, *Ripartites*, *Rozites*, *Simocybe*, *Tubaria*
- 6) Entolomataceae: *Alboleptonia*, *Claudopus*, *Clitopilus*, *Eccilia*, *Entoloma*, *Inopilus*, *Leptonia*, *Nolanea*, *Pouzarella*, *Rhodocybe*
- 7) Gomphidiaceae: *Chroogomphus*, *Gomphidius*
- 8) Hygrophoraceae: *Camarophyllus*, *Humidicutis*, *Hygrocybe*, *Hygrophorus*
- 9) Lepiotaceae: *Chlorophyllum*, *Cystolepiota*, *Lepiota*, *Leucoagaricus*, *Leucocoprinus*, *Macrolepiota*, *Pseudobaeospora*
- 10) Paxillaceae: *Paxillus*, *Phylloporus*
- 11) Pluteaceae: *Chamaeota*, *Pluteus*, *Volvariella*
- 12) Russulaceae: *Lactarius*, *Russula*
- 13) Strophariaceae: *Kuehneromyces*, *Melanotus*, *Naematoloma*, *Pachyleprium*, *Phaeomarasmius*, *Pholiota*, *Pleuroflammula*, *Psilocybe*, *Stropharia*
- 14) Tricholomataceae: *Armillaria*, *Armillariella*, *Asterophora*, *Baeospora**, *Callistosporium*, *Calocybe*, *Cantharellula*, *Catathelasma*, *Cheimonophyllum*, *Chrysomphalina*, *Clitocybe*, *Clitocybula**, *Collybia*, *Crinipellis*, *Cyptotrama*, *Cystoderma*, *Delicatula**, *Dermoloma*, *Fayodia*, *Flammulina*, *Gerronema**, *Heliocybe*, *Hemimycena*, *Hohenbuehelia*, *Hydopus**, *Hygrophoropsis*, *Hypsizygus*, *Laccaria*, *Lentinellus*, *Lentinula*, *Lentinus*, *Lepista*, *Leptoglossum*, *Leucopaxillus*, *Lyophyllum*,

Macrocystidia, *Marasmiellus*, *Marasmius*, *Megacollybia*^{*}, *Melanoleuca*, *Micromphale*, *Mycena*, *Myxomphalia*, *Neolentinus*, *Omphalina*, *Omphalotus*, *Ossicaulis*, *Oudemansiella*, *Panellus*, *Panus*, *Phyllotopsis*, *Phytoconis*, *Pleurocybella*, *Pleurotus*, *Porpoloma*, *Pseudoarmillariella*, *Pseudoclitocybe*, *Resinomycena*, *Resupinatus*, *Rhodotus*, *Rickenella*, *Rimbachia*, *Squamanita*, *Strobilurus*, *Tectella*, *Tricholoma*, *Tricholomopsis*, *Xeromphalina*^{*}, *Xerula*^{*}

Order: Aphyllophorales

15) Cantharellaceae: *Cantharellus*, *Craterellus*, *Gomphus*, *Polyozellus*

16) Schizophyllaceae: *Schizophyllum*

Note: * indicates genera which may be placed in the Xerulaceae, a modern family which is a segregate of the Tricholomataceae (Redhead, 1986).

Five genera of the Aphyllophorales were included in the key because they superficially resemble the true lamellate mushrooms (Agaricales).

DESIGN OF FUNGAL COMPUTER IDENTIFICATION KEYS

Very few computerized synoptic keys to fungi have been developed in the last decade. SYNKEY (Mycologue Publications, Sidney, B.C. V8L 1M8, Canada) is a computer key to 105 species of the ascomycete genus *Podospora* (Kendrick, 1990). This key has recently been reformulated for the Delta format on IBM compatible computers, courtesy of J. Brzustowski. PC-TAXON (now distributed by Mycena Consulting, Bellingham, Washington, U.S.A.) is a program developed by Fred Rhoades that has been used to create keys to genera of mushrooms, other macrofungi, and lichens of Whatcom County, Washington (Kendrick, 1990). TAXADAT, a program developed by Dr. Doyle E. Anderegg, was used to create a key to 47 species of the ascomycete genus *Lambertella* and runs on the Apple II+ (Korf & Zhuang, 1985). PENNAME, a dBASE key to 68 species of *Penicillium* species using 100 character states, was developed by Pitt (1991). A Fortran program created by Margot et al. (1984) runs on IBM and Apple computers as a key to 224 species of toxic agarics using 24 characters and 117 character states.

All of these keys have certain intrinsic disadvantages which may include slow algorithms, obsolete platforms, single selection entry for retrieval of character information (i.e., only one choice can be entered at a time and a tautological series of keystrokes have to be made before the next choice can be entered) (Kendrick, 1990; Adaskaveg et al., 1994). In addition, for these keys to perform well, the character states of all characters employed must be supplied for every taxon (Adaskaveg et al., 1994; Kendrick, 1990).

Adaskaveg et al. (1994) have developed PolyKey, a computer key to 100 genera and 415 species of polypore fungi (Aphyllophorales), using a spreadsheet program (Microsoft Excel 4.0). PolyKey can be operated on IBM-compatible MS-DOS or Apple Macintosh computers. Within this program, presence or absence of 43 character states was used (for a total of 86 character states) for identification at the genus level. At the species level the number of character states ranged from 8 to 59 depending on how many species were recognized in a particular genus. PolyKey appears to be well designed and very versatile in that it operates

strictly with mouse control and contains many modules which allow the user to perform various functions such as identification, education (display taxa descriptions), quiz (test the operator's knowledge of a given taxon), synonymy (view a list of taxonomic synonyms), definitions and help (terminology is explained), and print options of taxa features. PolyKey implements two different methods for its identification function; similarity and elimination.

One major drawback to PolyKey is that it utilizes rather few character states to identify a relatively high number of genera. This alone will limit how well the program operates. The program deals with basic characters related to basidioma attachment, flesh colour, basidiospores, surface texture, rot type, hymenophore, hyphal types, and cystidia. It is quite possible that the user will be unable to discern many of the characters which PolyKey requires, either because the specimen at hand is in poor condition or the operator has no access to a microscope. Characters which PolyKey lacks, and are undoubtedly important, include habitat (type of tree substrate), basidioma morphology, pigment, location of cystidia, basidiospore and cystidium shape, and quantitative features of the basidioma and basidiospores.

After taking most disadvantages of previous fungal computer keys into account, a different approach has been devised for the present study. A detailed computer key to gilled mushroom genera occurring in Canada has been developed utilizing askSam's capabilities as a database management program. The database file, AGARICS.ASK, is an upgraded version of the prototype mushroom computer key created by Kendrick (1990) which incorporated 80 genera. Major modifications have been made to the original mushroom key. A hypertext interface program that runs within askSam has been written (courtesy of John Brzustowski) to allow AGARICS.ASK to operate in a tiered, menu-driven way. Options within a given menu can be chosen (highlighted) using the cursor controls (arrows). The key incorporates 141 genera, 1,981 character states, and 78 menus.

It is clear that in using 1,981 character states, the disadvantage of having to go through a repetitive series of keystrokes for selecting character state options still remains. This is because there is not enough space on one computer screen to place 1,981 character states and permit the selection of the appropriate states. However, there is an option within the main menu of the program which will allow the user to enter keywords or combinations of keywords on a query line similar to that in the original prototype (Kendrick, 1990). Entering full key-words manually will allow only about 6 character states to be selected, though abbreviations, in which the latter part of each key-word is represented by an asterisk, increases this to 8 or 9. However, the menu design allows up to 15 characteristics to be chosen. The fact that the user doesn't have to memorize keywords, or refer to a long list, when using the menu format is a significant modification to the original key that makes it much easier for the inexperienced to use. The main menu contains a glossary option in which agaric terminology can be looked up quite easily, since this information is also menu-driven. A list of synonyms has been included for many terms within the glossary section and will, it is hoped, clear up any terminological confusion. Other special features exist in the main menu of the program and will be explained below.

The format of data storage follows that discussed by Kendrick (1990) and

Kendrick et al. (1994), in that each generic description is recorded in a separate record or document and the character states are coded with a three- or six-letter prefix derived from the character that contains it. For example a brown **spore print** is represented by SPPbrown and a **spore length** of 10µm by SPOLEN10. The way in which quantitative characteristics have been stored has been improved. If an agaric genus has spore lengths ranging from 5 to 13µm, this information is stored as SPOLEN>5 and SPOLEN<13 instead of SPOLEN5, SPOLEN6, ..., SPOLEN13 (which was the way quantitative characteristics were stored in the original key). This allows the user to enter any number, including one incorporating a decimal point.

The literature contains colour terms such as clay brown, chocolate brown, or rusty brown, which are imprecise. The colour of clay varies widely depending on the state of oxidation or reduction of the mineral. Does chocolate brown refer to the colour of dark chocolate or milk chocolate? Does rusty brown suggest brown/orange or brown/red (terms that could both be used within the key)? Since these terms can create confusion and are open to misinterpretation, they have been omitted.

The colour terms used in the key include the basic colours black, blue, brown, green, grey, pink, orange, red, yellow, violet (i.e. purple), and white. Excluding black and white, all basic colours have been modified with other basic colours. For example all of the various shades and tones of green would include green, pale/green (influenced by white), dark/green (influenced by black), green/blue, green/brown, green/grey, green/pink, green/orange, green/yellow, and green/violet. Note that green/red has not been chosen since these two colours are complimentary and therefore cancel each other out. A greenish-brown spore print is represented in the key as SPPbrown/green. Brown is placed before green because in this case it is the main contributing colour (i.e., has higher concentration: the word "green-ish" has weaker connotations than the word "brown"). Describing colours in this way creates what we hope is an ample number of states. If fewer colours were used, the comprehensiveness of the key would suffer, and if more colours were used, the user-friendliness of the key would decrease.

Terms referring to different sizes of scales, spines, or warts (either on the cap, stipe or spore surface) have also been excluded. Instead, the simple terms: scaly, spiny, and warty, have been applied. Terms such as verrucose, verruculose are diminutives of warty (warty > verrucose > verruculose). But what is the actual size of the warts themselves? The literature frequently does not specify. Students of agarics do acquire an intuitive feel for what the terms mean, but there is no concrete definition for "warty" with regard to dimensions, and yet there are definitions for verrucose and verruculose based on the concept that the objects in question are smaller than warts. This rationale is also applied to variations on scaly (squarrose, squarrulose, squamose, and squamulose) and a few other terms.

When computer keys are constructed it is important that characters or data be properly defined (Wolfe, 1986). In the present study, data consist of primary characters, secondary characters, and character states. For instance, a primary character could be the basidiospore. The secondary characters of the basidiospore would include shape, surface texture, colour, length, and width. The

character states would be the actual traits of the secondary character. For example, globose and ellipsoidal would be character states of basidiospore shape.

Proper definition of terms is essential since they help guide the sequence in which the menus are constructed. The first menu screen includes all of the primary characters. As the user enters the key, one of these characters is highlighted and entered to lead to a menu of its secondary characters. Choice of a secondary character leads to a third menu of character states. After an appropriate character state has been selected, it is automatically recorded on the main menu screen. The user can then either go through the series of menus again to choose another character state, or choose to see how many genera exhibit the character state which was chosen. The key works in a fashion that will eliminate more and more genera as the number of selected character states increases (i.e., as a synoptic key). Normally, the unknown genus will be identified when enough character states have been entered. Operation of AGARICS.ASK is explained and illustrated below.

OPERATION OF AGARICS.ASK

A sequence of computer screen displays is presented to demonstrate how the identification process of a mushroom genus is facilitated using AGARICS.ASK. The genus *Amanita* will be used as an example to show how identification may be accomplished. Performance of special commands will also be illustrated.

At the DOS prompt the user types in "AS AGARICS.ASK" to initiate the computer key. A prompt screen is displayed and instructs the user to press "Enter" to go to the main menu. The main menu screen is illustrated in Figure 1. The main menu consists of two columns. The first (left-hand) column with the heading "CHARACTERS CHOSEN" consists of 15 slots in which character states chosen from submenus will be placed. A character chosen will be positioned in the slot whose number is highlighted. The second column consists of a list of fundamental commands used in the identification process when at least one character state is displayed in the first column. However, the "Your_Own_AskSAM_Request" and "Create_Genus" commands can function only when the first column contains no characters. The "Browse_Glossary" and "Quit_To_DOS" commands can be executed any time the main menu is displayed.

Choosing an option within any menu can be achieved by highlighting it with the cursor controls and pressing the "Enter" key. Selecting any option which is prefixed with an under-line mark (i.e. "_") will lead to a submenu that has the option as its title. The identification protocol is initiated when one of the numbers in the first column of the main menu is highlighted and entered. This will display Figure 2 which is the primary character menu screen.

Since microscopic features and colour can differ between flesh and surface as well as between cap and stipe of the mushroom, the cap surface, cap flesh, stipe surface, and stipe flesh have been considered as primary characters of the fruiting body and thus have been placed within the primary character menu. Therefore the menus of _CAP_SURFACE, _CAP_FLESH, _STIPE_SURFACE,

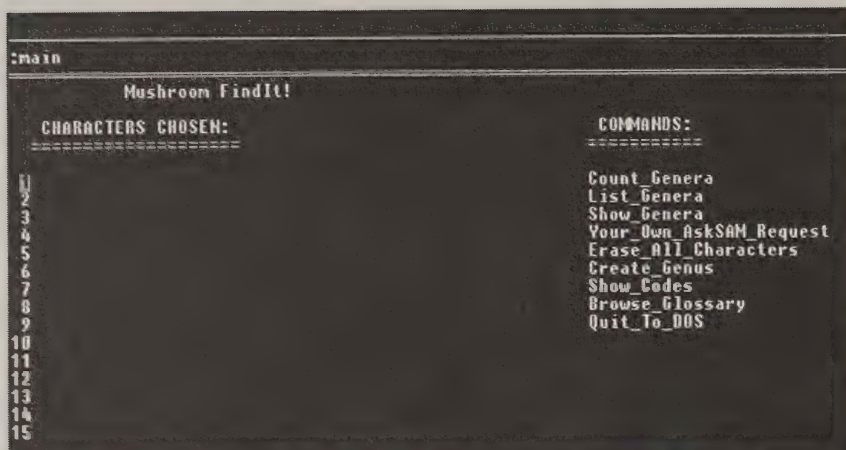


Figure 1. Main menu screen of AGARICS.ASK

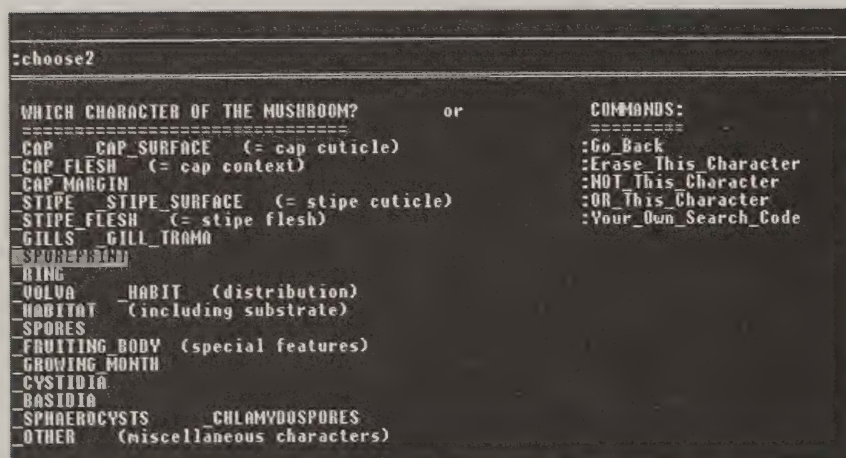


Figure 2. Primary character menu screen with "spore-print" selected.

and `_STIPE_FLESH` contain character states which pertain only to their microscopic and colour features. The primary character menus `_CAP`, `_CAP_MARGIN`, and `_STIPE` contain the macroscopic character states of size, shape, surface texture, and flesh consistency. The `_GILL_TRAMA` menu includes the microscopic features of the gill flesh as seen in cross section (i.e., hyphal arrangement, type, etc.) and the `_GILLS` menu includes the macroscopic traits. The `_FRUITING_BODY` menu includes unique or special features of the basidioma such as bioluminescence, deliquescence, type of development, etc. The `_OTHER` menu contains miscellaneous characters dealing with smell and taste. All other primary character menus obviously consist of character states which apply to the primary character.

A worked example follows.

The user has chosen `_SPOREPRINT` (i.e. spore print) as the first primary character (Figure 2). After pressing the "enter" key, the submenu with the title "`_SPOREPRINT`" is displayed (Figure 3). This menu contains all of the colours which can be attributed to the spore print. The operator has highlighted the colour "white". After this colour has been entered, the program has created and stored internally the keyword "SPPwhite" and the character "`_SPOREPRINT` white" has been placed in the first slot of the "CHARACTERS CHOSEN" column within the main menu (Figure 1). Figure 1 also shows the "Count_Genera" command. This command will count and display the number of agaric genera in the key which have the character(s) presented in the first column. After using the "Count_Genera" command the mushroom key reports that representatives of 86 mushroom genera produce a white spore print. After <Enter> is pressed, the main menu returns and the operator chooses slot number 2 (Figure 1). In Figure 4 "`_RING`" is selected as the second fundamental character. The option "Present" is selected in the "`_RING`" menu screen. Two character states would now be displayed in the main menu (Figure 1) and the command "Count_Genera" is chosen. The key then displays 26 genera of mushrooms possess both a white spore print and a ring.

The computer key has eliminated 60 genera of agarics with the addition of the second feature (i.e. presence of ring). The main menu is now ready to receive a third character. The option "`_VOLVA`" is picked within the primary character menu (Figure 4). "Present" is chosen in the Volva menu and this character is subsequently automatically displayed in the third slot of the main menu (Figure 1). The number of genera that have all three characters is down to 3. Twenty-three genera have been eliminated since the previous count. The operator can now list the names of the 3 genera by choosing the command "List_Genera". The genera *Amanita*, *Macrolepiota*, and *Squamanita* are shown in Figure 5 along with the families to which they belong, and the type species. The operator can now pick a fourth character. "`_GILL_TRAMA`" is chosen as the fourth character in the primary character menu (Figure 4). The operator chooses "divergent" in the `_GILL_TRAMA` menu. A divergent gill trama is a type of trama in which the hyphae diverge downward and outward from the central region of the gill and extend nearly to the lateral surfaces of the gill. Again the "Count_Genera" option is chosen and this time the computer key comes up with only 1 genus. When the "List_Genera" command is executed, the genus *Amanita* is displayed. Thus the operator has identified this mushroom genus using only four characters.

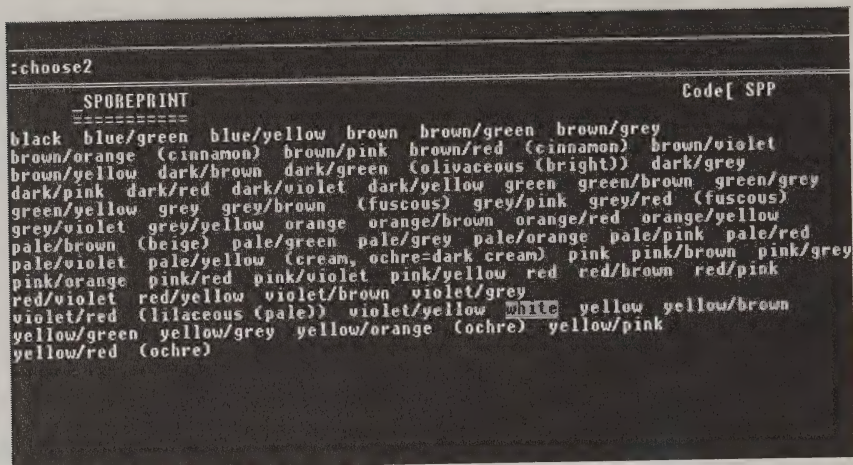


Figure 3. Spore-print menu with the colour "white" being selected.

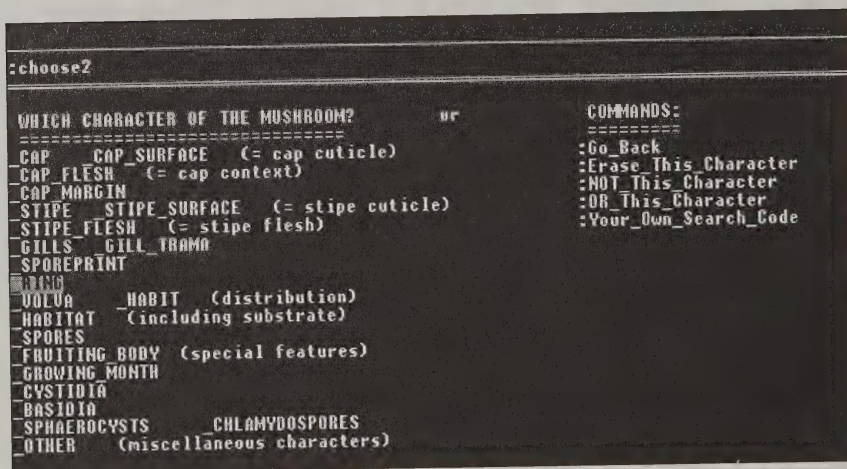


Figure 4. Primary character screen with "ring" selected.

```

EXECUTE PROGRAM  <Esc> hypertext  Print  <other> next screen
:do_search
AMANITA  (Amanitaceae)  A. muscaria (Linnaeus) Hooker
MACROLEPIOTA  (Lepiotaceae)  M. procera (Scop.) Singer
SQUAMANITA  (Tricholomataceae)  S. schreieri Imbach

                                -END-

```

Figure 5. Screen showing a list of generic names (with their type species) that have a white spore-print, ring, and volva.

```

EXECUTE PROGRAM  <Esc> cancel  Print  <other> next screen
:do_search
AMANITA  (Amanitaceae)  A. muscaria (Linnaeus) Hooker
Habitat: HABsoil HABhumus HABsand HABlawns HABdeciduous HABmixed HABbogs
        HABconifer ** HABfield (near trees)
Habit: HBTsingle ** HBTscattered ** HBTclustered HBTcaespitose HBTgregarious
        HBTfairy/ring/with/tree HBTsymbiotic (mycorrhizal)
Spore Print: SPPpale/green SPPpale/grey SPPpale/pink SPPpale/yellow SPPwhite **
Pileus: PILconvex PILovoid PILbell/shaped PILplane PILumbonate PILdepressed
        PILglabrous PILwarty ** (patches of universal veil which are grey, brown,
        yellow, or white) PILscaly (minutely) PILscales/appressed (rare)
        PILhairy (rare) PILviscid PILdry PILpruinose (rare) PILfelty PILsoft
        PILfleshy PILthin (rare) PILDIA>20 PILDIA<220 PILSUBbrown PILSUBgrey/brown
        PILSUByellow/brown PILSUBdark/brown PILSUBbrown/green PILSUByellow/green
        PILSUBgrey PILSUBbrown/grey PILSUBorange PILSUBbrown/orange
        PILSUBred/orange PILSUByellow/orange PILSUBpale/brown PILSUBpale/green
        PILSUBpale/grey PILSUBpale/yellow PILSUBbrown/pink PILSUBgrey/pink
        PILSUBred PILSUBbrown/red PILSUBorange/red PILSUByellow PILSUBbrown/yellow
        PILSUBgrey/yellow PILSUBwhite PILSUBshiny (some) PILSUBfilamentous
        PILSUBmonomitic PILSUBinamyloid PILSUBclamped PILSUBnot/clamped
        PILFLEpale/yellow PILFLEwhite PILFLEinamyloid PILFLEmonomitic
        PILFLEclamped (rare) PILFLEnot/clamped PILMAeven (then spores are amyloid)
                                -MORE-

```

Figure 6. First screen of *Amanita* description: note that any character selected during identification is highlighted.

The "Show_Genera" command is selected in the main menu, and brings up the generic description of *Amanita*. The four screens of the *Amanita* description are displayed in Figures 6, 7, 8 and 9. Notice that within the description screens the character states that were chosen are highlighted in darker text (i.e. SPPwhite, LAMTRAdivergent, RINpresent, and VOLpresent). All supposedly diagnostic or conservative characteristics for *Amanita* are labelled or tagged with two asterisks at the end. The description also includes a brief comments section at the end which mentions the edibility of the genus, number of species (in some cases), and how the genus differs from other closely related genera. Being able to view the description is advantageous since it can be compared with other characters of the specimen(s) at hand and the identification can be verified.

"Erase_All_Characters" is highlighted in the main menu screen so that the characters in the first column can be cleared and another identification can be initiated. The main menu is devoid of characters and ready to receive a first character again (Figure 1).

The operator who ran the computer key above used 4 characters to identify the genus *Amanita*. If the operator is more experienced in agaric taxonomy, it is possible to make an even faster identification by choosing first those characteristics which are most conservative within a given taxon. *Amanita*, can actually be identified by only using 2 characters (i.e. volva present and divergent gill trama).

In fact, repeated probing of the agarics.ask database has shown that many genera can be identified by entering only two characters.

If the operator is curious and wants to learn some of the keyword codes that the computer key employs for the features chosen, the "Show_Codes" option can be selected in the main menu and a screen will display the character codes. Figure 10 exhibits the codes VOLpresent and LAMTRAdivergent for the characters which were chosen by the operator to identify *Amanita*. The scientific name for gills is lamellae and therefore the gill trama can also be called the lamellar trama and so the six-letter prefix code used is LAMTRA.

The operator may also look up unfamiliar terminology used in the key by highlighting the "Browse_Glossary" option within the main menu. The first menu that appears is one containing words starting with the letter "A" (i.e. INDEX1). There are thus 26 glossary menus (i.e. 26 INDEX numbers corresponding to each letter of the alphabet). The user highlights and enters the word "amyloid" in the first glossary menu (Figure 11) and its definition is displayed along with the reference from which the definition was obtained.

Instead of proceeding through a series of menus and selecting characters one at a time, operators may also enter a combination of up to 5 or 6 of character keyword codes on the query line (provided that they are familiar with codes used in the key) to perform an identification. This can be done by selecting "Your_Own_AskSam_Request" in the main menu (Figure 1). When the user makes their own query request, whole generic descriptions will be displayed and the ability to list only the generic names is lost.

There are 5 other commands within the primary character menu as mentioned above (Figure 2). These commands include "Go_Back", "Erase_This_Character", "NOT_This_Character", "Or_This_Character", and "Your_Own_Search_Code". The "Go_Back" command allows the operator to


```

EXECUTE PROGRAM  <Esc> cancel      Print      ↑ <PgUp> <Other> next screen
:do_search

PILMARincurved (rare) PILMARwith/fragments PILMARstriae (then spores are
inamyloid) PILMARplicate PILMARsplit PILMARsulcate
Stipe: STIglabrous STIpruinose (rare) STIhairy (rare) STIfibrillose (appressed)
STIfibrillose/below/ring (rare) STIscaly/below/ring (rare) STIfleshy
STIsolid STIhollow STIcentral STIseparable STIequal STIclavate (rare)
STIradicating (rare) STIventricose (rare) STIbulbous STItapering/upward
STIpresent STIOIA>3 STIOIA<30 STILEN>30 STILEN<200 STISURyellow/brown
STISURyellow/green STISURgrey STISURpale/brown STISURpale/yellow
STISURyellow STISURwhite STISURred/violet STISURmonomitic STISURinamyloid
STISURclamped STISURnot/clamped STIFLEwhite STIFLEinamyloid
STIFLEclamped (rare) STIFLEnot/clamped STIFLEmonomitic
Lamella: LAMattached (finely) LAMadnexed LAMsinuate LAMfree ** LAMseceding
LAMbrown LAMPale/pink LAMPale/yellow LAMYellow LAMwhite LAMnarrow LAMBroad
LAMEven LAMfringed (rare) LAMmarginate (rare) LAMcrowded LAMclose
LAMsubdistant LAMdistant LAMtruncate (for young gills) LAMpresent
LAMNUM< LAMNUM< LAMSER> LAMSER< LAMTRAdivergent ** LAMTRAmomitic
LAMTRainamyloid LAMTRAcclamped LAMTRAnot/clamped
Annulus: RINpresent ** RINabsent RINsingle RINpendant RINevanescent
RINmembranous RINflaring RINwhite RINmedian (rare) RINsuperior
Volva: VOLpresent ** VOLconcentric/rings (some) VOLsaccate VOLindistinct
-MORE-

```

Figure 7. Second screen of *Amanita* description.

```

EXECUTE PROGRAM  <Esc> cancel      Print      ↑ <PgUp> <Other> next screen
:do_search

Taste: TASindistinct
Smell: SMEputrid SMEild
Basidiocarp: BASbivelangiocarpous BASpileocarpous BASstains/yellow/in/KOH (rare)
BASbruises/brown/red (rare)
Growing Month: GROJanuary GROFebruary GROMarch GROApril GROMay GROJune GROJuly
GROAugust GROSeptember GROOctober GRONovember GRODecember (December to
April on West coast)
Spores: SPObinucleate SPOhyaline SPOglobose SPOellipsoidal SPOcylindrical
SPObacilliform SPOsmooth SPOwarty (minutely & rare) SPOpunctate (minutely &
rare) SPOLEN>7 SPOLEN<16 SPOWID>3 SPOWID<13 SPOinamyloid (then cap margin
is striate) SPOamyloid SPOcyanophilous SPOthin SPOoff/centered
Cystidia: CYSpresent (rare) CYSabsent CYSpseudo (remnants of the universal veil
which adhere to the gill edge) CYScheilo CYSLEN> CYSLEN< CYSWID> CYSWID<
Basidia: BADwith/basal/clamp BADclavate BADtwo BADfour BADLEN> BADLEN< BADWID>
BADWID< BADSTE> BADSTE<
Sphaerocysts: SPHabsent
Comments: This is a widely accepted genus. Amanitopsis used to be the genus name
given to species of Amanita which lacked a ring. Over 100 species of
Amanita exist in North America (most are mycorrhizal). Some species are
deadly poisonous, some are edible, and some are hallucinogenic. A universal
-MORE-

```

Figure 8. Third screen of *Amanita* description, with a portion of the comments section displayed.

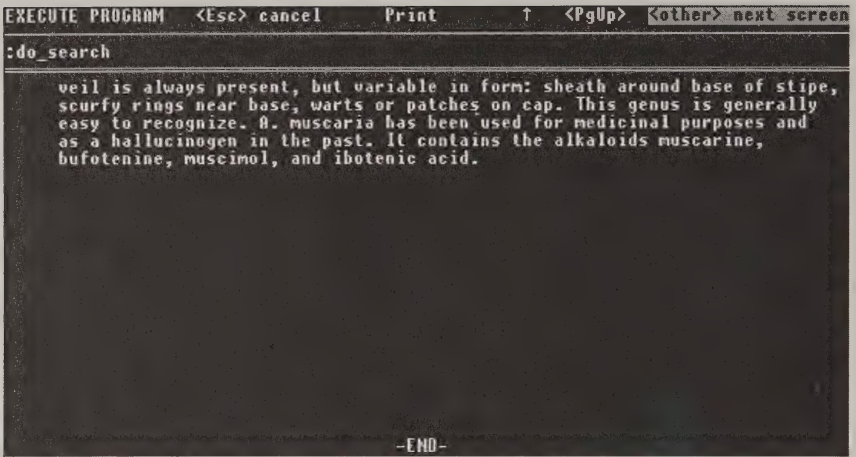


Figure 9. Fourth screen of *Amanita* description, with remainder of the comments section displayed.

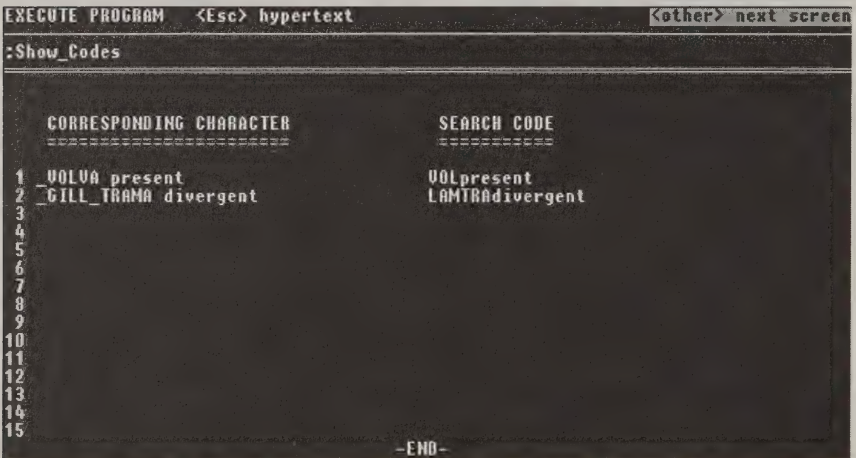


Figure 10. Screen showing the key-word codes for the characters chosen.

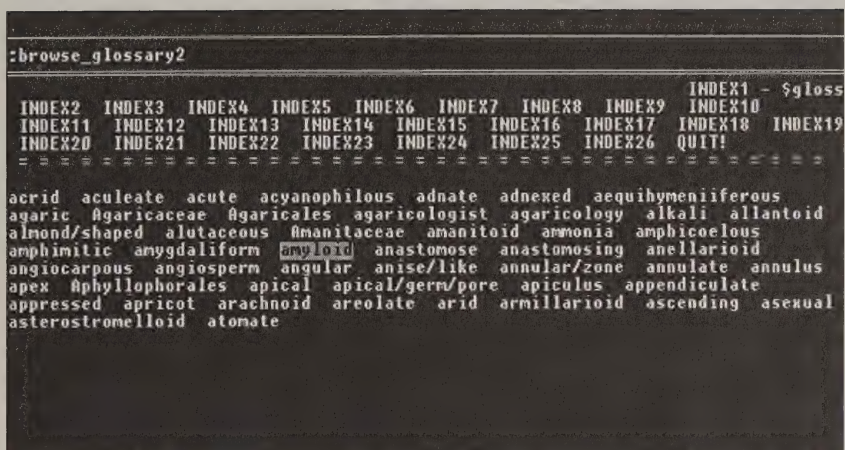


Figure 11. First index of the glossary with all terms starting with the letter "A" and the word "amyloid" selected.

return directly to the main menu without having to choose a primary character option. "Erase_This_Character" permits the user to erase any character in the list of characters chosen within the main menu, in case an incorrect choice has been made. The user may also employ Boolean logic by choosing the "Or_This_Character" or "Not_This_Character" command for any character highlighted within the main menu. If the operator is uncertain whether a character has one state or another, the "Or_This_Character" command can be selected. For example, the command may be employed when it is uncertain whether the cap surface colour is pale brown or pink. The key will count, list, or show the genera which contain either of these colours, but not necessarily both. "Not_This_character" may be used when the operator wants to count, list, or show genera which may contain a combination of characters chosen but definitely lacks another selected feature. This command works well only for genera which have characters with only a single character state (the presence of many states would decrease the usefulness of the command). "Your_Own_Search_Code" permits the operator to type in their own key-word similar to that made possible by the "Your_Own_AskSam_Request" command in the main menu. This keyword will then be positioned in the appropriate slot of the "Characters chosen" column in the main menu.

DISCUSSION

Creation and use of computer databases cum identification keys like AGARICS.ASK is an important step in resolving and re-evaluating some of the problems in agaric taxonomy, simply because information is rendered both more accessible and more manageable. Thus, computer keys like AGARICS.ASK may act as a catalyst not only in the identification of mushrooms but in accelerating the progress of agaricology by pinpointing the strengths and weaknesses of the present system.

Although a glossary to agaric terminology is included in AGARICS.ASK, some knowledge of the mushroom vocabulary and terminology, morphology, ecology, and biology of unknown agarics is required in order to run the identification key successfully. As in any systematic key, if a character has been incorrectly determined, the specimen at hand will most likely be misidentified or its identity remain unresolved. With manual keys one would have to back-track to find the misdetermined character or start the identification process over again. The computerized approach can speed up the entire process, and make attempts at identification more rewarding, or at least less frustrating, because the correctness of any character can be quickly checked.

Neville is currently incorporating the taxonomic data from AGARICS.ASK into a Microsoft Windows format. This format will incorporate the use of a SQL (Standard Query Language) database viewing program called LivePage (made by Inforium Inc., Waterloo, ON) in which the data is tagged up in SGML (Standard Generalized Markup Language). This new design will allow digitized photographs of representative taxa to be viewed along with the generic descriptions. The new format will also include a Windows program (created by Neville) to choose characteristics in a tiered, menu-driven manner similar to AGARICS.ASK.

Recently, encoding systems for taxonomic information have been generated and standardized for saprolegnialean fungi (Jong et al., 1991), yeasts (Jong et al., 1988), *Pythium* species (Jong et al., 1992), and *Phytophthora* species (Jong et al., 1989). Assembling of taxonomic information following standard codes could potentially lead to the creation of computer software for identification and analyzing the relationships among these fungal groups (Adaskaveg et al., 1994).

AGARICS.ASK provides a large number of character states (1,981), descriptions of 141 genera, and a comprehensive glossary to agaric taxonomy. AGARICS.ASK is the only computerized key to such a large number of agaric genera. This program could be applied to other groups of fungi and organisms, and we hope that the present study may encourage others to do that.

If you would like to obtain a copy of AGARICS.ASK please contact Bryce Kendrick and the database will be supplied to you on a 3.5" diskette or as a file attached to an E-mail message.

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TWO NEW MEMBERS OF THE SACCHAROMYCOPSIS CLADE: SACCHAROMYCOPSIS MICROSPORA, COMB. NOV. AND CANDIDA LASSENENSIS, SP. NOV.

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Abstract. *Saccharomyces microspora*, comb. nov. (type strain NRRL Y-7404, CBS 6393) and *Candida lasseusensis*, sp. nov. (type strain NRRL YB-3657, CBS 8524) are described. The species were recognized as novel from nucleotide substitutions in domain D1/D2 of 26S ribosomal DNA, a region that is sufficiently divergent to allow resolution of nearly all ascomycetous yeast species.

Key words: *Candida*, *Saccharomyces*, new yeasts, molecular systematics.

INTRODUCTION

Yeasts are often identified and classified on the basis of distinctive morphological features and from diagnostic reactions on a standardized set of physiological tests. Molecular comparisons, such as nuclear DNA reassociation (Price *et al.*, 1978; Kurtzman & Phaff, 1987) and ribosomal DNA (rDNA) sequence analysis (Kurtzman & Robnett, 1991), have shown that phenotypic properties are often not predictive of genetic relationships, and that many species and genera are likely to be poorly circumscribed. In view of this, Kurtzman & Robnett (1995, 1997, 1998) reexamined relationships among all currently recognized ascomycetous yeasts from analysis of nucleotide sequence divergence in the D1/D2 domain of large subunit (26S) rDNA. This region has been shown to be sufficiently variable to recognize nearly all ascomycetous yeast species as well as to provide phylogenetic resolution comparable to that obtained from small subunit (18S) sequence analysis (Peterson & Kurtzman, 1991; Kurtzman & Robnett, 1998).

One of the findings of these studies was that species of the teleomorphic genus *Saccharomyces* and its synonyms *Arthroascus*, *Botryoascus*, *Endomycopsella* and *Guilliermondella* represent a natural group. The comparisons further showed that *Pichia microspora* is a distinct species and not a synonym of *Saccharomyces synnaedendra*, as previously thought (Kurtzman & Smith, 1998). In addition, a new species of *Candida* was detected that is a member of the *Saccharomyces* clade. In this report, *P. microspora* is

transferred to the genus *Saccharomycopsis* as a new combination, and the novel *Candida* species is formally described.

MATERIALS AND METHODS

Organisms, fermentation and assimilation tests, single ascospore isolations.

Strains of the new species described, as well as reference strains, are maintained in the Agricultural Research Service Culture Collection (NRRL), National Center for Agricultural Utilization Research, Peoria, Illinois (Table 1). Fermentation and assimilation tests and the morphological examination of cultures are as described by Wickerham (1951) and Yarrow (1998), except that assimilation tubes were agitated on a reciprocal shaker at 25°C for the four-week incubation period.

To determine whether ascosporeogenous species were homothallic or heterothallic, single ascospore isolates were obtained from four-spored asci with a de Fonbrune micromanipulator using standard procedures as described by Fowell (1969). Asci of the type strain of *Saccharomycopsis synnaedendra* are persistent, and ascospores were released by digestion of ca. 0.5 mm³ of sporulating cells for 20 min at 25°C in 20 µl of the enzyme preparation Glusulase (Endo Laboratories, Inc., Garden City, New York). Asci of *Pichia microspora* are deliquescent, and ascospores of this species were removed from nearly degraded asci.

rDNA sequencing and sequence analysis

Methods for nuclear DNA isolation, amplification of the 600-nucleotide 26S rDNA domain D1/D2 by the polymerase chain reaction (PCR), and sequencing with the ABI TaqDyeDeoxy Terminator Cycle sequencing kit and the ABI Model 377 automated DNA sequencer (Applied Biosystems, Inc., Foster City, California) were previously described (Kurtzman & Robnett, 1997).

Sequence data were visually aligned with QEdit 2.15 (SemWare, Marietta, Georgia). Phylogenetic relationships were calculated with a Power Macintosh 8500/120 by the maximum parsimony program of PAUP* 4.0 (written by D. L. Swofford; test version distributed by Sinauer Associates, Inc., Sunderland, Massachusetts) with the simple heuristic search option. Relationships were further analyzed by the neighbor-joining program of PAUP* 4.0 with the Jukes-Cantor distance measure. *Schizosaccharomyces pombe* was the designated outgroup in all analyses. Confidence limits for phylogenetic trees were estimated from bootstrap analysis (1000 replications). The nucleotide sequences analyzed in this study have been deposited with GenBank under the accession numbers shown in Table 1, and were also reported in the studies of Kurtzman & Robnett (1995, 1998).

RESULTS

The 26S D1/D2 domain rDNA sequences of *Pichia microspora* and the proposed new *Candida* species differ significantly from each other and from all other known ascomycetous yeasts, and represent unique, genetically isolated species (Kurtzman & Robnett 1995, 1997, 1998). The relationships of these two species with other members of the *Saccharomycopsis* clade are shown in Fig. 1.

Table 1. Strains of *Saccharomycopsis*, *Candida* and reference species compared.

Species	Strain designation ¹		GenBank accession no. for D1/D2 sequences
	NRRL	CBS	
<i>Saccharomycopsis capsularis</i>	Y-17639 ^{NT}	2519	U40082
<i>S. crataegensis</i>	Y-5902 ^T	6447	U40079
<i>S. fermentans</i>	Y-17710 ^T	7830	U73600
<i>S. fibuligera</i>	Y-2388 ^T	2521	U40088
<i>S. javanensis</i>	Y-1483 ^T	2555	U40107
<i>S. malanga</i>	Y-7175 ^T	6267	U40135
<i>S. microspora</i>	Y-7404 ^T	6393	AF017725
<i>S. schoenii</i>	Y-17595 ^{NT}	7223	U40126
<i>S. selenospora</i>	Y-1357 ^T	2562	U40099
<i>S. synnaedendra</i>	Y-7466 ^T	6161	U40123
<i>S. vini</i>	Y-7290 ^T	4110	U40133
<i>Candida amapae</i>	Y-17845 ^T	7872	U69880
<i>C. lassenensis</i>	YB-3657 ^T	8524	AF017726
<i>Saccharomyces cerevisiae</i>	Y-12632 ^{NT}	1171	U44806
<i>Schizosaccharomyces pombe</i>	Y-12796 ^T	356	U40085

¹ T = type strain; NT = neotype strain; NRRL = Agricultural Research Service (ARS) Culture Collection, National Center for Agricultural Utilization Research, Peoria, Illinois, USDA; CBS = Centraalbureau voor Schimmelcultures, Delft, The Netherlands.

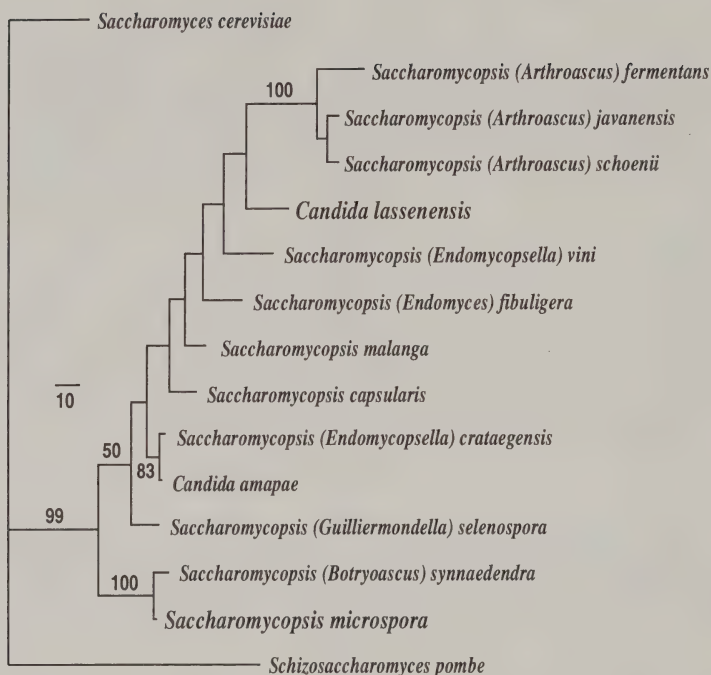


Fig. 1. Phylogenetic tree of the *Saccharomycopsis* clade represented by the single most parsimonious tree derived from maximum parsimony analysis of 26S domain D1/D2 rDNA (modified from Kurtzman & Robnett, 1998). Branch lengths are proportional to nucleotide differences, and the numbers given at nodes are the percentage of frequencies with which a given branch appeared in 1000 bootstrap replications. Frequencies under 50% are not given. Marker bar = 10 nucleotides. Tree length = 433, consistency index = 0.711, retention index = 0.598, rescaled consistency index = 0.425, homoplasy index = 0.289. *Saccharomycopsis capsularis* is the type species of the genus. Earlier genus assignments are given in parentheses. *Schizosaccharomyces pombe* was the outgroup species in the analysis.

Saccharomycopsis microspora (Batra) Kurtzman, comb. nov. Basionym: *Pichia microspora* Batra. Mycologia 63:995. 1971.

Vegetative growth and ascospore formation by *Pichia microspora* were well illustrated by the photomicrographs of Batra (1971). Reactions on fermentation and assimilation tests commonly used in yeast taxonomy were determined for this species in the present study and are given in Table 2.

Ascosporeulation by NRRL Y-7404, the type strain, was abundant on 5% Difco malt extract agar after 3 days at 25°C. Ascospores are hat-shaped, and four are usually formed in each ascus. Asci become deliquescent at maturity. Single ascospores were isolated from 8 asci, and 27 of the 32 ascospores were viable. All single-spore isolates produced highly sporogenous colonies indicating that *S. microspora* is homothallic. Cultures from the following representative tetrad were placed in the ARS Culture Collection: NRRL Y-7404-17, -18, -19, and -20.

Phylogenetic analysis showed *S. microspora* and *S. synnaedendra* to be sister species (Fig. 1). For comparison, single-spore isolates were also obtained from *S. synnaedendra*. The type strain, NRRL Y-7466, gave abundant ascosporeulation on YM agar (Wickerham, 1951) after 3 weeks at 25°C. Asci are persistent for this strain and usually form four hat-shaped ascospores. Single-spore isolates were obtained from 9 asci, and 17 of the 36 ascospores were viable. All single-spore isolates gave highly sporogenous colonies, which demonstrated that *S. synnaedendra* is homothallic. Cultures of the representative tetrad NRRL Y-7466-5, -6, -7, and -8 were placed in the ARS Culture Collection.

Comments: *Saccharomycopsis microspora* and *S. synnaedendra* give identical responses on the standard fermentation and assimilation tests used in yeast taxonomy. For the type cultures, which were the only strains compared in the present study, *S. microspora* forms deliquescent asci whereas the asci of *S. synnaedendra* are persistent. The two taxa differ by 8 nucleotides in the 600-nucleotide domain D1/D2. Because strains showing this much divergence have never been found to be conspecific (Kurtzman & Robnett, 1998), the two isolates are regarded as sister species that would be expected to be genetically isolated from one another.

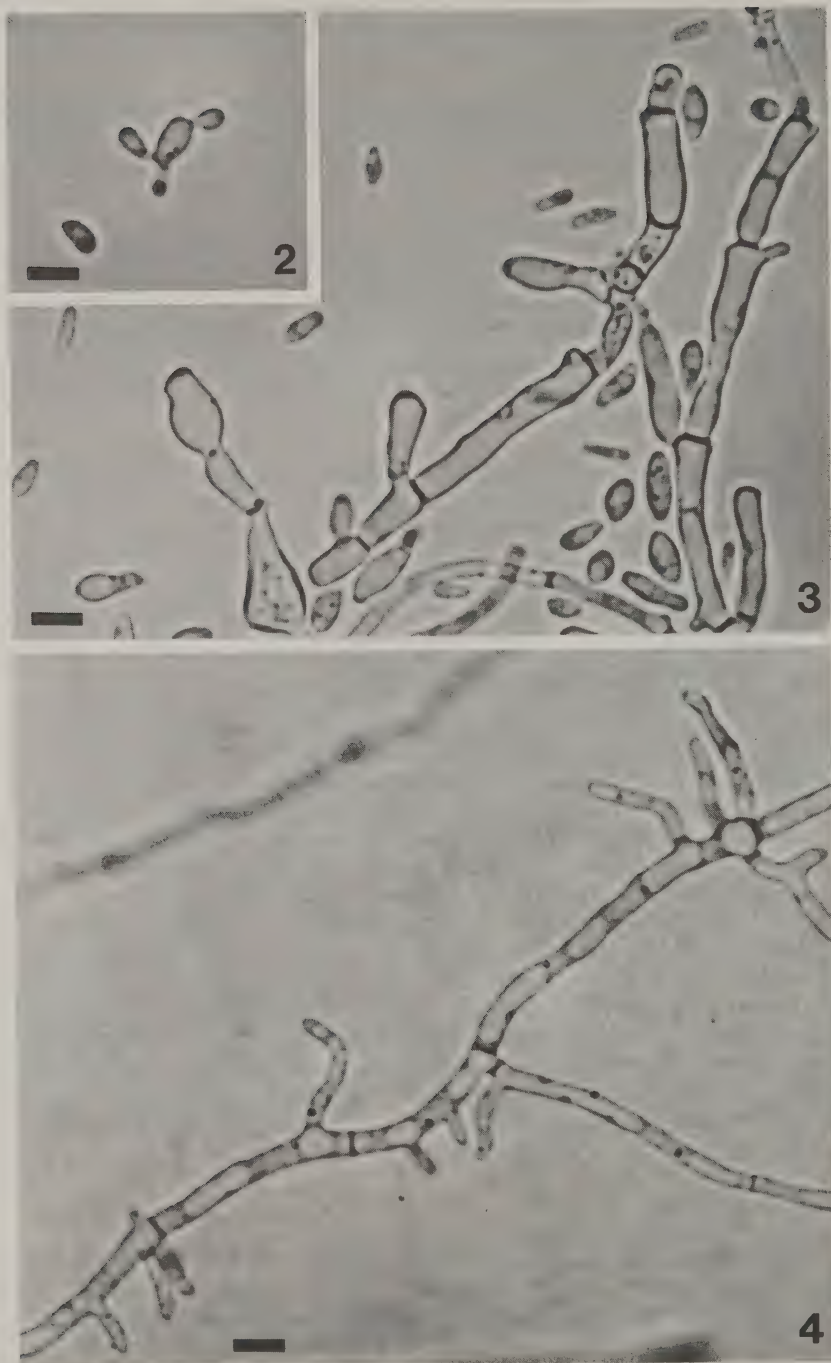
Candida lassenensis Kurtzman, sp. nov.

In agaro malti post dies 3 ad 25°C, cellulae vegetativae ellipsoideae aut elongatae (2.0-3.5) x (3.0-11.0) µm, singulae aut binae. Fiunt pseudohyphae et hyphae verae. In agaro morphologico post dies 7 ad 25°C, incrementum fuscum pallidum, hebes, butyrosum aut mycelialis; centrum coloniae sublatum; margo glabro vel undulato.

Ascosporae non fiunt.

Saccharas non fermentantur.

Assimilantur glucosum, galactosum, maltosum, cellobiosum, trehalosum (variabile), amyllum solubile, D-arabinosum (variabile), D-ribosum, ethanolum, glycerolum, erythritolum, ribitolum, D-mannitolum, D-glucitolium, D-gluconas, 2-keto-D-gluconas, 5-keto-D-gluconas, acidum succinicum (lente), acidum citricum (variabile), et inositolum. Non assimilantur



L-sorbosum, sucrosum, lactosum, melibiosum, raffinose, melezitose, inulin, D-xylose, L-arabinose, L-rhamnose, D-glucosamine, *N*-acetyl-D-glucosamine, methanol, galactitol, α -methyl-D-glucoside, salicin, saccharates, DL-acidum lacticum, hexadecanum, cadaverinum et potassii nitras. Amylum non formatur. Vitaminae externae ad crescentiam necessaria sunt. Gelatinum liquescit; esteres non fiunt; pellicula non fiunt. Augmentum fiunt in temperatura 37°C.

Typus: NRRL YB-3657 (CBS 8524), designat stirpem typicam. Isolata a *Ips oregoni* in *Pinus contorta* var. *latifolia*, Mt. Lassen, California, U.S.A., depositata in Collectione Culturarum ARS (NRRL), Peoria, Illinois U.S.A.

Description of *Candida lassenensis*

Growth on 5% malt extract agar: After 3 days at 25°C, the cells are ellipsoidal to elongate (2.0-3.5) x (3.0-11.0) μ m, and occur singly or occasionally in pairs (Fig. 2). Budding is multilateral. Growth is tannish-white, low convex, dull and butyrous to mycelial.

Growth on the surface of assimilation media: Pellicles are not formed.

Dalmau plate culture on yeast morphology agar: After 7 days at 25°C, pseudohyphae and true hyphae are formed under the coverglass (Figs. 3, 4), but in contrast to aerobic growth, they are devoid of blastoconidia. Aerobic growth is dull to faintly glistening, white in color, butyrous to mycelial, and low convex with a slightly raised center. The margin is sparingly lobed. A faintly acidic odor is present.

Examination for the presence of an ascospore state: Ascospores were not detected in cultures of the only known strain of *C. lassenensis* when grown for up to 3 months on 5% malt extract agar or YM agar at 15° and 25°C. Spherical (6-8 μ m) to elongate (4-6 x 8-10 μ m), empty, ascus-like cells were commonly produced after 1 week and were either free or formed as terminal or intercalary cells on hyphae.

Fermentation and assimilation tests: Reactions on the fermentation and assimilation tests commonly used in yeast taxonomy are given in Table 2.

Source of the culture: NRRL YB-3657 (UCD-FST 52-129) was isolated by Moshe Shifrine from an adult specimen of the bark beetle *Ips oregoni* that had infested a lodge pole pine (*Pinus contorta* var. *latifolia*) growing in the Mt. Lassen area of California. NRRL YB-3657 was isolated during a study of yeasts associated with bark beetles that was reported by Shifrine & Phaff (1956), but this particular strain was not cited in that publication (H. J. Phaff, personal communication). The unidentified strain was sent by Emil Mrak in 1954 to L. J. Wickerham, who placed it in the ARS Culture Collection where it awaited further study.

Type: NRRL YB-3657 (CBS 8524), preserved as a lyophilized preparation, Agricultural

Figs. 2-4. *Candida lassenensis*. 2. Budding yeast cell, 5% Difco malt extract agar, 3 days, 25°C. 3. Pseudohyphae, YM agar, 3 days, 25°C. 4. True hyphae from under the coverglass of a Dalmau plate, yeast morphology agar, 7 days, 25°C. Short hyphal cells are convoluted on this agar medium, which is typical for *Saccharomycopsis* spp. Marker bars = 5 μ m.

Table 2. Physiological characteristics of *Saccharomycopsis microspora* and *Candida lassenensis*.

Physiological Test	Reaction of ¹		Physiological Test	Reaction of	
	<i>S. microspora</i>	<i>C. lassenensis</i>		<i>S. microspora</i>	<i>C. lassenensis</i>
Fermentation:	-	-			
Assimilation:					
Glucose	+	+	Methanol	-	-
Galactose	-	w	Ethanol	+	+
L-Sorbose	-	-	Glycerol	+	+
Sucrose	-	-	Erythritol	+	+
Maltose	+	+	Ribitol	+	+
Cellobiose	-	+	Galactitol	-	-
Trehalose	-	v	D-Mannitol	+	+
Lactose	-	-	D-Glucitol	+	+
Melibiose	-	-	α -Methyl-D-glucoside	-	-
Raffinose	-	-	Salicin	-	-
Melezitose	-	-	D-Gluconate	+	+
Inulin	-	-	2-Keto-D-gluconate	-	+
Soluble Starch	+	+	5-Keto-D-gluconate	v	+
D-Xylose	+	-	Saccharate	-	-
L-Arabinose	-	-	DL-Lactate	v	-
D-Arabinose	v	v	Succinate	w, +	w
D-Ribose	+	+	Citrate	-	v
L-Rhamnose	+	-	Inositol	+	+
D-Glucosamine	-	-	Hexadecane	-	-
N-Acetyl-D-glucosamine	-	-	Nitrate	-	-
Additional growth tests:					
Vitamin-free medium	-	-	Gelatin liquefaction	+	+
Cadaverine	-	-	Cycloheximide 0.01%	+	+
10% NaCl/5% glucose	-	-	Cycloheximide 0.1%	+	-
Starch formation	-	-	Growth at 37°C	-	+

¹ -, negative; +, positive; w, weak; v, variable when repeated, i.e., + or -.

Research Service Culture Collection (NRRL), Peoria, Illinois U.S.A.

Etymology: *lassenensis*, from Mt. Lassen, California, the only known source for this species.

Comments: The species key of Payne *et al.* (1998) identifies *C. lassenensis* as *Saccharomycopsis synnaedendra*, but a comparison of responses on commonly used physiological tests (Kurtzman & Fell, 1998) shows that *C. lassenensis* can be separated from other described species of *Saccharomycopsis* from its growth on galactose, as well as from the character combination of growth on cellobiose and 2-keto-D-gluconate and absence of glucose fermentation.

DISCUSSION

Phylogenetic analysis of gene sequences offers a rapid and accurate means for recognizing yeast species. Peterson & Kurtzman (1991) and Kurtzman & Robnett (1991, 1995, 1997, 1998) found that sequences of the 600-nucleotide D1/D2 domain at the 5' end of large subunit (26S) rDNA are sufficiently variable to resolve nearly all known ascomycetous yeasts. Strains that differ by three (0.5%) or fewer substitutions are generally conspecific, whereas strains with six (1%) or more substitutions are separate species, as assessed from genetic crosses and from measurements of nuclear DNA reassociation. A few exceptions to these predictions have been found. Several closely related species pairs, such as *Saccharomyces bayanus*/*S. pastorianus* and *Pichia stipitis*/*P. segobiensis* have identical or nearly identical D1/D2 sequences, whereas complementary mating types of *Metschnikowia agaves* differ from one another by five substitutions (Kurtzman & Robnett, 1998). As a consequence, extent of relatedness among strains showing 1% or fewer substitutions should be verified by a second method, such as measurements of nuclear DNA complementarity or genetic crosses, if possible. At present, there are no known conspecific strains that differ by more than 1% substitutions in the D1/D2 domain. Consequently, even though each of the new species described here is represented by a single isolate, it is predicted that each is reproductively isolated from known relatives.

The genus *Saccharomycopsis* is unique because of the variety of ascospore shapes found among assigned species. This variation prompted transfer of species with distinctive ascospores into the genera *Arthroascus*, *Botryoascus*, *Endomycopsella* and *Guilliermondella* (van der Walt & von Arx, 1980; von Arx, 1972; von Arx & Yarrow, 1984). Phylogenetic analysis of partial sequences from large subunit rDNAs indicate that the various species are members of a single clade, and these species were reassigned to *Saccharomycopsis* by Kurtzman & Robnett (1995). *Saccharomycopsis* is a relatively small genus and it is of interest to find new members, such as the two taxa characterized in the present study.

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Names of equipment and chemical suppliers are necessary to report factually on experimental methods; however, the USDA neither guarantees nor warrants the standard of the products, and

the use of the name by USDA implies no approval of the product to the exclusion of others that may also be suitable.

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THE STATUS OF THE GENUS *BOVISTOIDES* (*GASTEROMYCETES*)

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ABSTRACT

A revision of the genus *Bovistoides* Lloyd was undertaken, as a result of which it was confirmed that the holotype *B. simplex*, is a weathered, imperfect specimen of *Myriostoma coliforme*. Consequently *Bovistoides* becomes a synonym of *Myriostoma* as suggested by Long and Sunhede. The second known species included by Lloyd in the genus –*B. torrendii*– is the holotype of a new genus proposed by Ponce de León, namely *Acutocapillitium*.

KEY WORDS: Lycoperdaceae, *Bovistoides*, *Myriostoma*, *Disciseda*

INTRODUCTION

The inclusion of the genus *Bovistoides* Lloyd in the latest edition of Ainsworth & Bisby's Dictionary of the Fungi (Hawksworth et al., 1995) on the authority of Ponce de León (1976) as a synonym of *Disciseda* Czernaiev is an error which requires correction.

Lloyd (1919) created the genus *Bovistoides* for material sent by Miss A. V. Duthie from South Africa, for which he gave the following description: "... Plants 1-1/2 cm. in diameter. Peridium smooth, soft papery brown. Gleba brown. Sterile base none. Capillitium of simple, short, wavy, colored threads, with acute ends. About 6 mic. thick at the thickest portion. Spores globose, 8 mic. strongly tubercular, having somewhat the appearance of

Scleroderma spores. ...", and included in it the only known species *B. simplex* Lloyd.

Later, (Lloyd 1922) he added to the genus another species, namely *Bovistoides torrendii* based on materials sent by Rev. C. Torrend from Brazil.

Long (1942) after upon an exhaustive study of the types of the genus *Bovistoides*, concluded that *B. simplex* Lloyd, is a "weathered, depauperate" and detached specimen of *Myriostoma coliforme* (Dickson: Pers.) Corda pointing out that "the surface is silvery brown and rough; the base of the specimen plainly shows seven little finger-like stubs typical of the external columellae of *Myriostoma*, while in the glebal cavity seven columellae are also visible. The color, columellae, spores and capillitium are identical to those of *Myriostoma coliforme* Corda.", but lacks the outer star-shaped exoperidium. Furthermore he suggests that *B. torrendii* Lloyd is a collection of *Myriostoma coliforme* which was collected immature and whose real dehiscence is not apparent, but that the microscopic features of the gleba exclude it from the latter species. Finally, Long questioned the validity of the genus *Bovistoides* altogether, and suggested it should be dropped.

Cunningham (1942) included *Bovistoides* in *Disciseda* (p. 135), but did not mention anything about *B. simplex*. Bottomley (1948) included it in *Disciseda* (p. 566), but gave *B. simplex* as another synonym of *Myriostoma coliforme* (p. 605).

Staněk (1958) also included *Bovistoides simplex* as a synonym of *M. coliforme* (p. 400), and was the first to hint who had made this statement by writing after the record of the citation of *B. simplex*: "(fide Long)".

Ponce de León (1976), on the one hand, from the study of the holotype of *Bovistoides simplex* (Lloyd cat. n° 32447) and collections of *Disciseda*, confirmed *Bovistoides* as a synonym of *Disciseda*, and suggested that *B. simplex* probably was *D. minimum* Dring. On the other hand, based on the very peculiar capillitium of *B. torrendii*, the second species included by Lloyd (1922) in *Bovistoides*, Ponce de León (op. cit.) segregated it under a new genus, *Acutocapillitium torrendii* (Lloyd) P.de

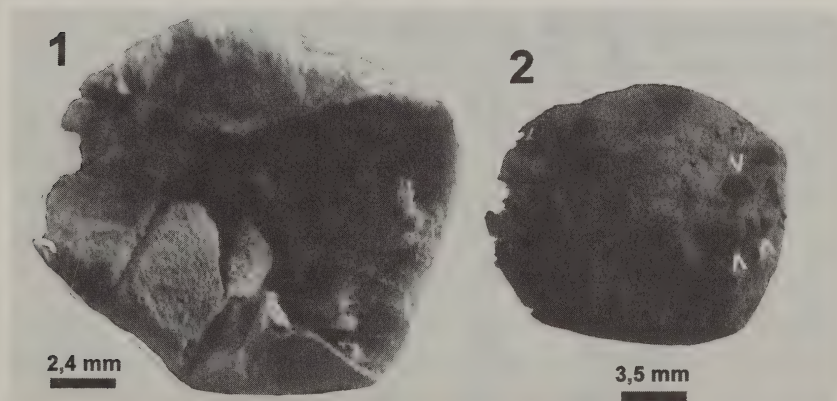
León.

Sunhede (1989) comments in his discussion of *Myriostoma coliforme* that *B. simplex* is synonymous with *M. coliforme* "according to Long and Stouffer (1948, p.585)". Apparently he did not study Lloyd's type; as *B. simplex* was not in the list of synonyms.

From our observations of the type collection of *Bovistoides simplex* we offer a detailed description of it:

Bovistoides simplex Lloyd, Mycological Notes N°61 (Vol VI), pg.883, 1919.

Fruitbody transversely narrowly elliptic or depressed, ovate, 1.5 cm diam. Dehiscence not evident on account of the poor condition of the holotype (Fig. 1). No stomata are evident. At the base of the endoperidium about 6-7 small excrescences are observed corresponding to the stalks presumably uniting the exoperidium with the endoperidium (Fig. 2).



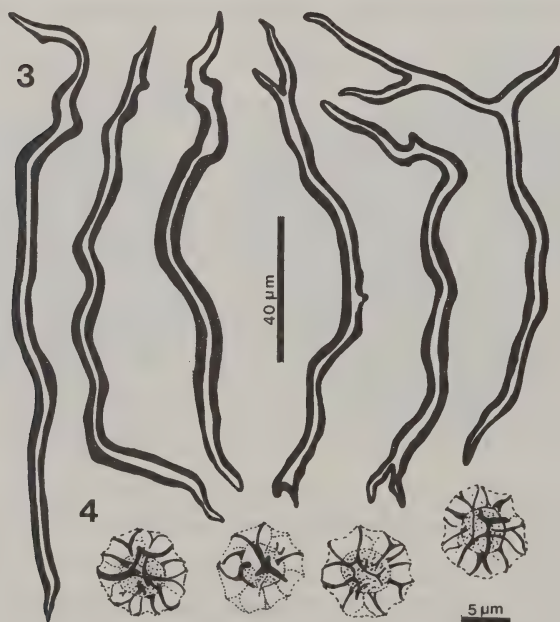
FIGS. 1-2. *Bovistoides simplex* Lloyd (Holotype- BPI 711521). 1: Upper view of the gastrocarp. 2: Lower view of the gastrocarp, showing remnants of the stalks (arrows).

Peridium (endoperidium) thin, papyraceous, smooth, felted chestnut (Plate 15, 10-11 de A-L), Maerz & Paul (1930); we were unable to see the silvery sheen characteristic of the peridium of *M. coliforme* which was

observed by Long (1942).

Subgleba absent. Gleba powdery, chestnut, concolorous with the peridium, only two collumellae were observed (7 according to Lloyd).

Peridium formed by a single layer of thickwalled hyphae, 2-5 μm diam., entangled but not losing their individuality, some dichotomously branched. Capillitium formed by independent thick-walled hyphae, tortuous, simple, mostly unbranched (a few with dichotomous branching threads), 80-460 μm x 3-4,5 μm long, yellowish brown in water mounts with a visible (most) to lacunar to solid (few) lumen. The ends of these threads are pointed and closed (Fig. 3). Noteworthy are the sporadic spiny excrescences of the outer wall of the capillitium, observed both under LM and SEM somewhat suggesting those of the genus *Mycenastrum* (Fig. 5); but here much smaller and less abundant. Neither true nor false septa were observed; pores are also absent.



FIGS. 3-4. *Bovistoides simplex* Lloyd (Holotype). 3: Capillitium. 4: spores under LM.

Spores globose, strongly ornamented, without pedicels, 4-5 μm diam without the ornamentation, 8-10 μm with ornamentation. Under LM (Fig. 4) the ornamentation appears to have a irregularly spiny processes united by a hyaline halo, up to 3 μm ; under SEM (Figs. 6-7) they appear somewhat reticulate with a pseudospiralled, incomplete ornamentation, resembling a large, sectioned sea-shell.

Holotype studied: SOUTH AFRICA, Transvaal, Leg.: Miss A. V. Duthie, det.: Lloyd cat. n° 32447, **BPI 711521** sub *Bovistoides simplex* Lloyd.

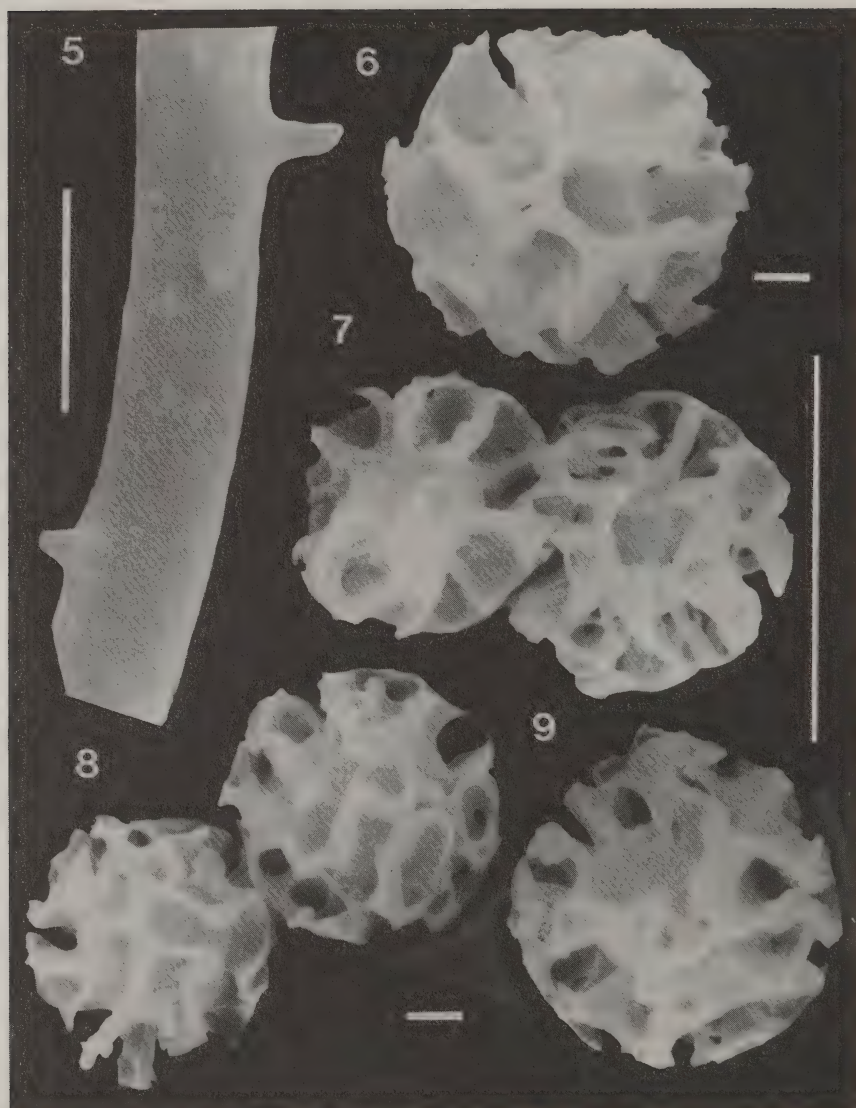
Comparison with other collections: ARGENTINA: Buenos Aires, La Plata, Parque Pereyra Iraola, leg.: M. Izaguirre, 10-VI-1995, **BAFC 33.963** sub *Myriostoma coliforme* (With.:Pers.) Corda. Corrientes, Dpto. Capital, alrededores, leg.: S. Zabala, X (fines)- 1947, sobre tierra, **BAFC 23342** sub *Myriostoma coliforme* (With.:Pers.) Corda. BRAZIL: leg.: Rev. C. Torrend, det.: Lloyd cat. n° 32448, on a stump, **BPI 711519** sub *Bovistoides torrendii* Lloyd (Holotype!).

From a comparison of our observations with the detailed description and illustrations of *M. coliforme* given by Sunhede (1989), and the spores under SEM of the latter species, both by Eckblad (1971) and Sunhede (1989), as well as from Argentine collections of *M. coliforme* (Wright, 1949) cfr. photo (Figs. 8-9), it can be stated without doubt that *B. simplex* Lloyd is identical with *Myriostoma coliforme* (With.: Pers.) Corda.

Thus *Bovistoides* is reduced to synonymy with *Myriostoma* and *B. simplex* becomes a synonym of *M. coliforme*, whereas *B. torrendii* has good standing as *Acutocapillitium torrendii* (Lloyd) Ponce de León.

ACKNOWLEDGEMENTS

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FIGS. 5-9. Photomicrographs of spores and capillitium under SEM. 5: Capillitium of *Bovistoides simplex* Lloyd (Holotype- BPI 711521). 6-7: Spores of *Bovistoides simplex* Lloyd (Holotype- BPI 711521). 8-9: Spores of *Myriostoma coliforme* (With.: Pers.) Corda [8: BAFC 33963 from La Plata; 9: BAFC 23342 from Corrientes]. Bars: Figs. 5 and 7 = 10 μ m; Figs. 6, 8 and 9 = 1 μ m.

Thanks are due to the curator of the BPI herbarium for the loan of type materials in her keeping.

Special thanks are due to Drs. Miller and Halling for critically reading the typescript, to Dr. Andrea Romero for her useful suggestions and to Dr. E. Zalocchi for his valuable assistance.

Also we wish to thank Mr. Dante Giménez (CITEFA) for the SEM micrographs.

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PERICONIA FLABELLIFORMIS ANAM. SP. NOV.

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Abstract

Periconia flabelliformis is described as a new dematiaceous species characterised by the tree- or fan-like aspect of the fungus conidiomata on dead graminaceous plants. Groups of 25-35 conidiophores closely aggregated in the basal part form a stalk 150-250 µm tall and 80-150 µm wide, then expand as a fan 200-250 µm tall, 350-400 µm wide, which appears crowded with conidia, and the conidiophore setiform apices stick out as ribs 80-200 µm in length. Illustrations are given with line-drawings and SEM graphs. Comparisons are made with other congeneric taxa.

Key words: *Periconia*, New taxa, Mitosporic fungi, Graminaceous hosts, Hyphomycetes.

Introduction

In late December 1997 and in the first quarter of 1998, dead grass stems and leaves were collected on which conidiomata of two types of the dematiaceous genus *Periconia* Tode were observed. One of the colony types was recognised as *P. hispidula* (Pers.: Pers.) E.W. Mason & M.B. Ellis; the other showed morphological differences from the so far known *Periconia* species that warrant the description of a new taxon, for which the specific epithet *flabelliformis* is proposed considering the fan-like aspect of the conidiomata on the natural substratum.

Material and Methods

Grass samples were collected at four different localities in NE Spain: three in Tarragona (Catalonia), at 600-880 m altitude, and one in Huesca (Aragón), at 800-900 m. Routine mycological techniques using light optical systems were employed in the study of the samples. For SEM investigations selected conidiomata on the hosts were air-dried, coated with gold and observed with a Hitachi 2300 SEM.

Taxonomy

Periconia flabelliformis Munt.-Cvetk., Hoyo & Gómez-Bolea, sp. nov.

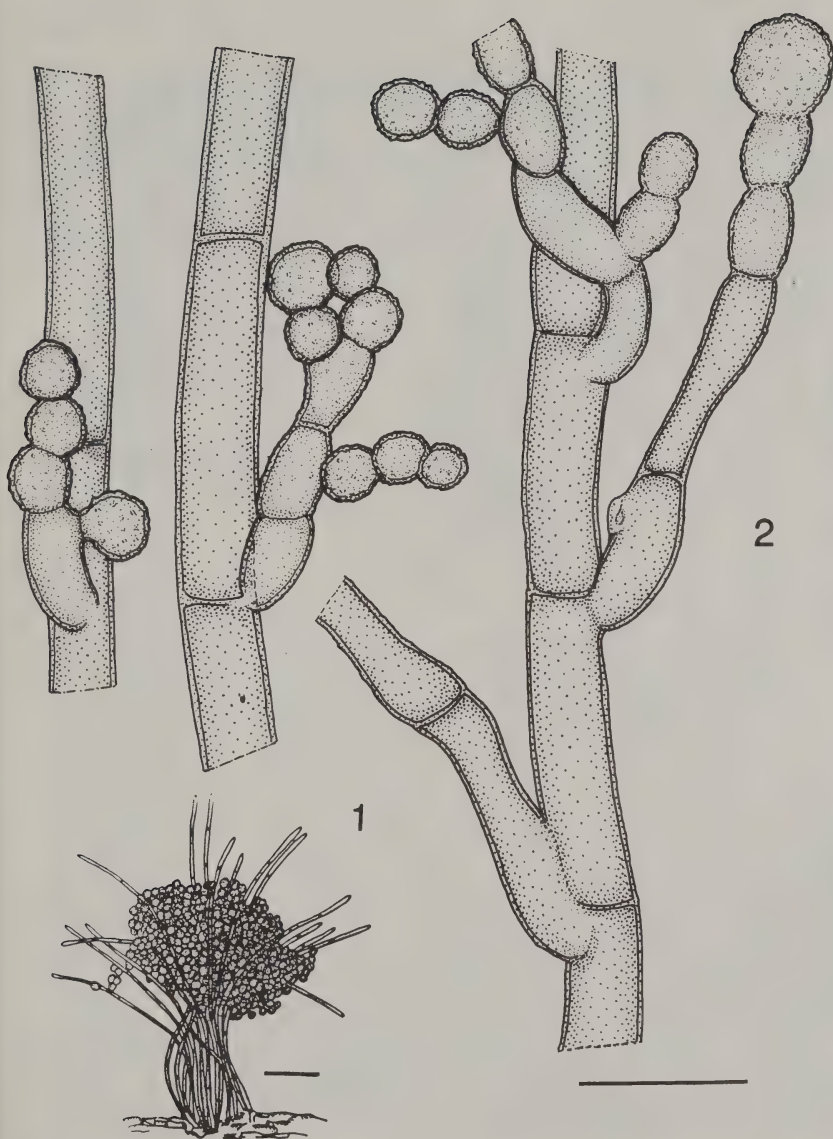
Fructificationes super hospite erectae, fuscae, arboriformes vel flabellatae, cum synnematoso sterile basem, 150-250 μm altus et 80-150 μm latus, ex 25-35 conidiophoris, inferne aggregatis deinde expansis in flabelliformem et fertilem partem mediam, ad apicem setosis composito. **Conidiophora** macronematosa, erecta, recta vel leniter flexuosa, rubro-brunnea, 400-600 μm longa, subuliformia, 8-10 μm diametro basi, 5.5-7 μm apice, fertilia ad expansam 200-250 μm longam et 350-400 μm latam partem mediam, sterilia ad 80-200 μm longum apicem, laevia, septata, septis inter se 50-60 μm ad basem, 20-35 μm superne, remotis. **Cellulae conidiogenae** monoblasticae vel polyblasticae, ex utrimque lateribus conidiophori partis mediae prodeuntia, initio globosae vel subglobosae et laeves, demum longiora et leviter scabrae, 15-40 x 7-9 μm . **Conidia** singularia vel ramosa catenulata, acropleurogena, rubro-brunnea, globosa, parietibus 1.5-2.2 μm crassis, grosse verrucosis, ad maturitatem vulgo 13-14 μm diam.

Teleomorphosis ignota.

ICONES: Figs. 1-5.

TYPUS: In emortuis partibus gramineae ignotae, Hispania, Catalonia, Tarragona, Alt Camp, Querol, Font de Jovany, 880 m (U.T.M.: 31TCF7086), 13.III.1998 a P. Hoyo lectus et in herbario barcinonense sub numero BCC Myc. 414/1 servatus.

Conidiomata on the substratum scattered, tree- or fan-like in section, consisting of a sterile stout synnematosus stalk 150-250 μm tall and 80-150 μm wide, composed of 25-35 conidiophores closely aggregated in the basal part, further expanding as a fan in a middle portion crowded with conidia, and conspicuously surpassed by the conidiophores setiform apices, 80-200 μm in length (Fig. 1). *Conidiophores* macronematous, erect, straight or slightly flexuous, reddish brown, 400-600 μm tall, subulate, 8-10 μm thick at the base



Periconia flabelliformis. Fig. 1: Aspect of a conidiomata on the natural substratum, Bar = 100 μm . Fig. 2: Fertile portion of a developing conidiophore, Bar = 20 μm .

(Fig. 3) and tapering to 5.5-7 μm at the rounded apex (Fig. 4), fertile in the 200-250 μm long and 350-400 μm wide middle part, sterile in the 80-200 μm long setiform upper part, smooth, septate, with 50-60 μm distance between septa at the basal portion and 20-35 μm upwards. *Conidiogenous cells* mono- or polyblastic, initially globose or subglobose and smooth, later subcylindrical and minutely verruculose, looking like multicellular branches born on either sides of the conidiophore, 15-40 x 7-9 μm (Fig. 2). *Conidia* single or in short branched acropleurogenous chains, reddish brown, globose or subglobose, with 1.5-2.2 μm thick and coarsely verrucose walls (Fig. 5), mostly 13-14 μm in diam when mature, including ornamentation.

Teleomorphosis not known.

TYPE: On dead parts of non identified Gramineae, NE Spain, Catalonia, Tarragona, Alt Camp, Querol, Font de Jovany, 880 m (UTM: 31TCF7086), March 13, 1998, *P. Hoyo*, BCC Myc 414/1.

ETYMOLOGY: From the Latin *flabellum*, fan; *flabelliformis*, fan-shaped.

MATERIAL EXAMINED: On dead parts of Gramineae, Spain, Catalonia, Barcelona, L'Arboçar, 600 m (U.T.M.: 31TCF6881), Dec. 7, 1997, *P. Hoyo*, BCC Myc 412 (two folders); Tarragona, Alt Camp, Querol, Puig de Montagut, 880 m (U.T.M.: 31TCF6885), March 13, 1998, *P. Hoyo*, BCC Myc 413 (mixed with *P. hispidula*); Tarragona, Alt Camp, Querol, Font de Jovany, 850 m (U.T.M.: 31TCF7086), March 13, 1998, *P. Hoyo*, BCC Myc 414/2 (mixed with *P. hispidula*); Aragón, Huesca, Pano, 800-900 m (U.T.M.: 31TBG78), April 10, 1998, *P. Hoyo*, BCC Myc 415 (mixed with *P. hispidula*).

Discussion

Rao & Rao (1964) observed that, although a slight variation is not uncommon, the arrangement of the stipes in a colony is very useful in *Periconia* classification. We consider that, moreover, the setiform character of the conidiophores is an additional worthy attribute. On this basis two main groups could be distinguished:

I) *Periconia* species with non-setose conidiophores gathered in fascicles, as in *P. saraswatipurensis* Bilgrami, *P. stilbacearum* P. Rag. Rao & D. Rao, *P. tirupatiensis* Subram., *P. yadagirensis* P. Rag. Rao & D. Rao, and others (Rao & Rao, 1964; Ellis, 1976), all of them with rather short conidiophores and rather small conidia. None has so far been encountered during our studies on biodiversity in Catalonia (Muntañola-Cvetković *et al.*, 1997 and 1998).

II) *Periconia* species with long sterile setiform conidiophore apices. Species in this group could be subdivided into three subgroups:



Periconia flabelliformis. Figs. 3 and 4: base and apex, respectively, of conidiophores. Fig. 5: Conidia at different stages of maturity; the verrucose ornamentation of the wall is coarser in the oldest, uppermost conidium. (For all figs., Bars = 10 μ m)

- a) With scattered conidiophores, as for instance in *P. lateralis* Ellis & Everh., *P. pseudolateralis* de Hoog & V.G. Rao (de Hoog & Rao, 1975) or *P. fusiformis* Munt.-Cvet., Hoyo & Gómez-Bolea.
- b) With conidiophores densely aggregated in the basal portion, forming scattered, tree- or fan-like colonies, as in *P. flabelliformis*.
- c) With conidiophores forming pulvinate colonies or bristly mats as in *P. hispidula* (Pers.: Pers.) E. W. Mason & M. B. Ellis (Mason & Ellis, 1953), *P. genistae* Lunghini or *P. sahariana* Lunghini (Lunghini, 1978).

The main features of three species representing each one of these subgroups, i.e. *P. fusiformis*, *P. flabelliformis* and *P. hispidula*, are represented in Table 1.

Tab. 1. Microscopic structures of *P. fusiformis*, *P. flabelliformis* and *P. hispidula*

	<i>P. fusiformis</i>	<i>P. flabelliformis</i>	<i>P. hispidula</i>
Conidiomata on natural substrat.	fusiform	tree-or fan-like	pulvinate
Conidiophores arrangement	solitary	aggregated at the base	as lax fascicles
length	420-1200 μm	400-600 μm	450-800 μm
base width	14.5-16 μm	8-10 (-12) μm	4.8-6.3 μm
apex width	4.5-6 μm	5.5-7 μm	2.5-3 (-4) μm
Mature conidia diam.	(9-) 12 (-13) μm	13-14 μm	(10-)15-16 μm
ornament.	verrucose	coarsely verrucose	short-echinulate

P. fusiformis has been selected for the comparisons in order to underly that *P. flabelliformis* conidiomata are not aggregates of *P. fusiformis* conidiophores. In *P. fusiformis* the stipes are solitary and branches and conidiogenous cells are subverticillate, always subseptal and appressed.

In *P. hispidula* the colonies are pulvinate, thus differing conspicuously from the scattered fan-like ones of *P. flabelliformis*. Compared to *P. flabelliformis*, the conidiophores in *P. hispidula* are much longer, thinner and lax, and distances between septa are irregular. Although differences in conidial size have been found among samples of *P. hispidula* collected during our studies (10-13 μm and 10-16 μm in Muntañola-Cvetković *et al.*, 1997),

and also with respect to those given by other authors (10-16 μm in Ellis, 1971), conidia in *P. hispidula* are in general larger (Table 1).

Acknowledgements

Sincere appreciation is expressed to Prof. J. Vigo (Univ. Barcelona) for his kind assistance with the Latin diagnosis, to Dr. E. Descals (CSIC/UIB) for his kind suggestions and to Prof. J. Guarro for their pre-submission review of the manuscript. The Electron Microscopy Service of the University of Barcelona provided the electron microscope facilities for this study, as well as technical assistance.

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CLADISTIC ANALYSIS OF EUROPEAN SPECIES OF RHIZOPOGON (BASIDIOMYCOTINA) BASED ON MORPHOLOGICAL AND MOLECULAR CHARACTERS

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Abstract

Relations between *Rhizopogon roseolus*, the most common false truffle in Europe, and other species with simple peridium (Sect. *Rhizopogon*) were analysed on the basis of the morphological characters and their ribosomal ITS 2 sequences. *R. luteolus*, the type species of the genus and of the Sect. *Rhizopogon*, clusters in a separate clade from *R. roseolus*. Molecular data analyzed by both parsimony and distance methods support that Sect. *Rhizopogon* is paraphyletic. Substitution rate calibration applied to ITS2 sequences from the *Rhizopogon* collections and 24 other Boletales sequences retrieved from the GenBank confirm the results under parsimony: *Rhizopogon* is monophyletic and it is a sister group of *Suillus* s.l. including *Boletinus* and *Fuscoboletinus*.

Key words: *Rhizopogon*, *Suillus*, *Basidiomycotina*, ITS2, phylogeny.

INTRODUCTION

The species of the genus *Rhizopogon* Fr. & Nordholm, popularly called "false truffles", develop angiocarpic basidiomes and show hypogeous or semihypogeous habit. Like other hypogeous fungi, *Rhizopogon* develops basidiomes of quite simple structure. Although there are very few morphological characters to separate closely related taxa, morphological characters provide the basis of current systematics in *Rhizopogon*. Smith & Zeller (1966), after studying 2500 samples, described 137 species in North America (121 new taxa) on the basis of correlating macro and microscopic features with some of the most reliable chemical tests used in epigeous fungi

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(Melzer's reagent, potassium hydroxide and iron sulfate). However, as discussed in Martín (1996) and later by Martín *et al.* (1997), some of these characters were overvalued by these authors, because they are related with degrees of maturation of basidiomes. Smith & Zeller (1966) divided the genus *Rhizopogon* into two subgenera, subg. *Rhizopogonella* A.H. Smith [= *Alpova* Zeller & Dodge, according to Trappe (1975)], and subg. *Rhizopogon* A.H. Smith (= *Rhizopogon* Fr. & Nordholm s.e.). According to the kind of spore and the peridium type, species of *Rhizopogon* Fr. & Nordholm s.e. are separated into four sections (Hosford, 1972; Martín, 1996): *Amylopogon*, *Fulviglebae*, *Rhizopogon* and *Villosuli*.

A close phylogenetic relationship between *Rhizopogon* and members of the *Boletaceae* Chevall. has been suggested by a number of prestigious mycologists (Malençon, 1931; Heim, 1934; Heim, 1948; Pegler & Young, 1981). Bruns *et al.* (1989), demonstrated the close relationship between *Rhizopogon* and *Suillus* s.l., by comparing part of the mitochondrial large RNA gene. A phylogenetic analysis based on sequences of the entire ITS region has been carried out for a number of *Suillus* s.l. species using *Gomphidius glutinosus*, *Chroogomphus vinicolor*, *Rhizopogon subcaerulescens* and *Truncocolumella citrina* as outgroup (Kretzer *et al.*, 1996). In this study, the genus *Suillus* s.l. appears to be a monophyletic sistergroup of *Rhizopogon*. Grubisha *et al.* (1997) in a preliminary phylogenetic analysis of the ITS of rDNA in a number of *Rhizopogon* collections, mainly from North America, consider this genus monophyletic. In this study, we analyse the relationship between *Rhizopogon roseolus*, the most frequent species of this genus in Europe (Martín, 1996), and other species collected in Europe from the same section (Sect. *Rhizopogon*) by performing a phylogenetic analysis of this section using both morphological and sequence data (Internal Transcribed Spacer region 2). Furthermore, to find out whether Sect. *Rhizopogon* is a natural group, in the analyses two species of other sections were included (*R. subcaerulescens*-Sect. *Amylopogon* and *R. villosulus*-Sect. *Villosuli*).

The ITS2 sequences were compared with ITS2 of other Boletales, mainly *Suillus* species, received from the GenBank (Bilofsky and Burks, 1988).

MATERIALS AND METHODS

Materials

The basidiomes used in this study belong to the herbarium collections listed in Table 1.

Table 1. List of specimens used in this study. Taxon name according to Martín (1996)

Taxon name	Geographical area	GenBank Acc. Num.
<i>R. corsicus</i> Demoulin et Moyerson, LG-Demoulin 4580 (Isotype)	Corse, France	AF115833
<i>R. corsicus</i> Demoulin et Moyerson, LG	Limburg, Belgium	AF115834
<i>R. luteolus</i> Fr. & Nordholm, BCC-MPM 2504	Pontevedra, Spain	AF115835
<i>R. luteolus</i> Fr. & Nordholm, Sarasini 520	Girona, Spain	AF115836
<i>R. rocabrunae</i> M.P. Martín, BCC-MPM 1995.o	Girona, Spain	AF115837
<i>R. rocabrunae</i> M.P. Martín, BCC-MPM 1995.y	Girona, Spain	AF115838
<i>R. rocabrunae</i> M.P. Martín, BCC-MPM 1862 (Holotype)	Girona, Spain	AF115839
<i>R. roseolus</i> (Corda) Th. M. Fr., BCC-MPM 1511	Mallorca, Spain	AF115840
<i>R. roseolus</i> (Corda) Th. M. Fr., Sarasini 286	LI, Italy	AF115841
<i>R. roseolus</i> (Corda) Th. M. Fr., Sarasini 451	PI, Italy	AF115842
<i>R. roseolus</i> (Corda) Th. M. Fr., Sarasini 521	Girona, Spain	AF115843
<i>R. roseolus</i> (Corda) Th. M. Fr., Sarasini 612	TN, Italy	AF115844
<i>R. subsalmonius</i> A.H. Smith, BCC-MPM 1653	Girona, Spain	AF115845
<i>R. subsalmonius</i> A.H. Smith, Smith 65350 (Holotype)	Ida, USA	AF115846
<i>R. villosulus</i> Zeller & Dodge, BCC-MPM 1800	Barcelona, Spain	AF115847

Character definition and codification

Sixteen morphological characters, discussed in Martín (1996), were used in this study. Earlier authors split out *Rhizopogon roseolus* complex into two, three, four or five species according to the spore size and spore volume. For the five collections belonging to the species *R. roseolus* ss Martín, spore volume was calculated (Table 2), according to Gross & Schmitt (1974), as $V=0.5 \times w^2 \times l$ (volume of the rotation ellipsoid, where w =spore width and l = spore length). Characters and character states used for cladistic analysis are shown in Table 3.

DNA extraction

Herbarium specimens were visually examined, and portions of the specimens that appeared to be in good condition were removed with a razor blade after the external surfaces were scraped off.

The extraction procedure followed the method of Gardes *et al.* (1991), with minor modifications. Approximately 2 g of basidiome fragments were ground in 600 µl of lysis buffer (1.4 M NaCl, 0.1 M Tris-HCl, 20 mM EDTA, 2% CTAB, 0.2% β-mercaptoethanol) with a plastic pestle, except for type material which only 50 mg were ground in 300 µl of the lysis buffer. After incubating for 60-120 min at 65°C, the suspension was centrifuged for 5 min at 2000 x g. The supernatant was transferred to a new tube and extracted with one volume of chloroform. The aqueous phase

Table 2. *R. roseolus* collections included in this study. Spore volume calculated according to Gross & Schmitt (1974) and taxon names according to Gross, Runge & Winterhoff (1980).

	Spore Volume μm^3	Gross, Runge & Winterhoff (1980)
<i>R. roseolus</i> , BCC-MPM 1511	60.0	<i>R. roseolus</i> (Corda) Th. M. Fr
<i>R. roseolus</i> , Sarasini 286	45.0	<i>R. luteorubescens</i> A.H. Smith
<i>R. roseolus</i> , Sarasini 451	30.0	<i>R. vulgaris</i> (Vitt) M. Lange var. <i>intermedius</i> Svrcek
<i>R. roseolus</i> , Sarasini 521	30.0	<i>R. vulgaris</i> (Vitt) M. Lange var. <i>intermedius</i> Svrcek
<i>R. roseolus</i> , Sarasini 612	60.0	<i>R. roseolus</i> (Corda) Th. M. Fr

was removed and DNA was precipitated with two volumes of isopropanol at -20°C for 30 min. DNA was harvested by centrifugation for 30 min at $13000 \times g$. The pellet was washed with 70% ethanol and resuspended in 100 μl TE buffer (10 mM Tris-HCl, 1 mM EDTA).

PCR amplification

PCR amplifications were performed by using a Perkin-Elmer Cetus DNA thermal cycler (model GenAmp 2400). The primer pair ITS3/ITS4 was used to amplify the ITS2-region, as described by White et al. (1990). PCR reactions were done in a total reaction volume of 100 μl containing approximately 1 ng of total DNA, 60 pmol of each primer, 1.5 units of Taq-polymerase, 200 μM dNTP, 10 mM Tris-HCl, 1.5-3.0 mM MgCl_2 and 5 μM KCl. Cycling parameters were an initial denaturation at 95°C for 3 min, followed by 35 cycles of denaturation at 95°C for 2 min, annealing at 50°C for 22 sec and extension at 72°C for 1 min, with a final extension at 72°C for 10 min. Negative controls, without DNA template, were prepared in every series of amplification in order to exclude the possibility of contamination in reagents or reaction buffers.

Successful PCR reactions resulted in a single band observed on a 1.3 % agarose gel (LE-agarose, FMC BioProducts, Rockland, Mayne, USA), corresponding to approximately 450 bp. Each PCR-product was cleaned using the QIAquick PCR purification kit (QIAGEN Inc., Chatsworth, CA, USA).

DNA sequencing

Sequences were determined with an Applied Biosystems (Foster City, CA, USA) 373A sequencer using the Taq DyeDeoxi TerminatorTM cycle system (PERKIN ELMER). All isolates were sequenced at least once using each of the primers ITS3 and ITS4 (White et al. 1990).

Table 3. Characters (Martín, 1996) and character states used for cladistic analysis of *Rhizopogon*.

Character	Character states
1. Distribution of rhizomorphs	0=covering the whole basidiome; 1= at the base of the basidiome
2. Peridium surface	0= smooth; 1= squamulose
3. Basidiome consistency	0= friable; 1= bone-like
4. Gleba chambers	0= labyrinthoid; 1= regular.isodiametric
5. Peridium reaction to KOH	0= negative; 1= red-orange; 2= olivaceous; 3= bronze noir
6. Peridium reaction to FeSO ₄	0= negative; 1= burnt umber to inky black; 2=green
7. Gleba reaction to KOH	0= negative; 1= revives colours
8. Gleba reaction to FeSO ₄	0= negative; 1= revives colours
9. Epicutis	0= present; 1= not present
10. Subcutis type	0= roseolus; 1= luteolus; 2= corsicus; 3= abietis
11. Hyphal tip shape between peridium and gleba	0= lanceolate or obclavate; 1= not lanceolate or obclavate
12. Peridium pigments	0= intracellular; 1= extracellular in granules; 2= extracellular amorphous
13. Oleiferous hyphae	0= present; 1= not present
14. Brachybasidioles wall	0= thick; 1= thin
15. Basidia	0= clavate; 1= cylindric; 2= lageniform (some clavate or cylindric)
16. Spore base	0= rounded; 1= truncate

DNA sequence alignment

Sequence alignment was performed with program SEQED from the Genetics Computer Group (GCG) Sequence Analysis Software Package Version 7.1 (Devereux, Haeberli & Smithies, 1984). Further adjustments were made by eye where necessary. Where ambiguities in the alignment occurred, the alignment chosen was the one generating the fewest potentially informative characters. Alignment gaps were marked “-” and unresolved nucleotides or unknown sequences were indicated by “N”. Two alignments were done, one including the fifteen sequences from Table 1 and sequences of *Rhizopogon subcaerulescens* and *Truncocolumella citrina* retrieved from the GenBank® (Table 4) and a second alignment in which twenty two other sequences from the GenBank® belonging to epigeous Boletales (Table 4) were added to the previous alignment. The alignment files can be accessed through WWW at <http://www.ctv.es/USERS/fgfigueres/MariPaz/mpmartin.htm>.

Phylogenetic analyses

In order to study the relationship between *Rhizopogon roseolus* and other European species of *Rhizopogon*, as well as to determine if Sect. *Rhizopogon*

Table 4. Ribosomal DNA sequences included in analyses.

Taxa	Accession Number
<i>Chroogomphus vinicolor</i> (Peck) Miller, TDB.1010	L-54095
<i>Gastrosuillus laricinus</i> (Singer & Both) Thiers, EB.2030	M91611
<i>Gastrosuillus laricinus</i> (Singer & Both) Thiers, EB.2031	M91612
<i>Gomphidius glutinosus</i> (Schaeff. : Fr.) Fr., TDB.953B	L54114
<i>Rhizopogon subcaerulescens</i> Smith, F.2882	M91613
<i>Suillus asiaticus</i> (sing.) Kretzer & Bruns, JV.4850F	L54090
<i>Suillus bovinus</i> (L. : Fr.) Kuntze, AD.3	L54077
<i>Suillus cavipes</i> (Opat.) Smith & Thiers, TDB.646	L54105
<i>Suillus collinitus</i> (Fr.) Kuntze, J3.15.2	L54089
<i>Suillus decipiens</i> (Berk. & Curt.) Kuntze, DG.1451	L54079
<i>Suillus granulatus</i> (Fr.) Kuntze, AD.11	L54076
<i>Suillus grevillei</i> (Klotzsch) Singer, EB.2040A	M91614
<i>Suillus grisellus</i> (Peck) Kretzer & Bruns, TDB.574	L54101
<i>Suillus laricinus</i> (Berkeley ex Hooker) Kuntze, VC.1231	L54120
<i>Suillus luteus</i> (Fries) Gray, TDB 824	L54110
<i>Suillus ochraceoroseus</i> (Snell) Singer, SAR.84137	L54093
<i>Suillus paluster</i> (Peck) Kretzer & Bruns, GT.831015/15	L54080
<i>Suillus punctipes</i> (Peck) Singer, TDB.265	L54098
<i>Suillus sibiricus</i> (Singer) Singer, VC.1040	L54117
<i>Suillus sinuspaulianus</i> (Pomerleau & Smith) Dick & Snell DAOM.66995	L54078
<i>Suillus spectabilis</i> (Peck) Kuntze, TDB.641	L54104
<i>Suillus tridentinus</i> (Bres.) Singer, HB.325	L54082
<i>Suillus variegatus</i> (Swartz : Fr.) Kuntze, HB.325	L54081
<i>Truncocolumella citrina</i> Zeller (Schaeff. : Fr.) Fr., TDB.2001	L54097

is a natural group or not, parsimony and distance analyses of the morphological and sequence data were carried out separately using the computer program PAUP (Swofford, 1993; version 3.0s) and TREECON (Van de Peer & De Watcher, 1996).

In the parsimony analysis, which minimizes the number of mutational events necessary to account for the sequence differences, all characters were treated as unordered and all multistate morphological characters were treated as non-additive. Gaps were treated as characters in this study because they may contain phylogenetic information and provide particularly clear indications of relationship (Lloyd & Calder, 1991; Revera & Lake, 1992; Baldwin, 1993). Parsimony trees were constructed using heuristic methods. Branch robustness was estimated by bootstrap analysis (Felsenstein, 1985) of 1000 heuristic replicates. *Truncocolumella citrina* was used as outgroup because members of this genus have been shown to be closely related to *Suillus* and *Rhizopogon* (Bruns *et al.*, 1990; Kretzer *et al.*, 1996);

moreover, morphological features of *Rhizopogon* apply better to *Truncocolumella citrina* than to any *Suillus* or *Gastrosuillus* species.

With TREECON software, the distance matrix from the morphological data was calculated according to the similarity index of Nei & Li (1979) and from the molecular data as suggested by Van de Peer (per. com.) using the evolution model of Jukes & Cantor (1969) that is the simplest method of estimating the number of nucleotide substitutions. Trees were constructed by neighbor-joining (not ultrametric distance: distances from the root to each terminal node are not the same) and branch robustness was estimated by bootstrap analysis of 1000 heuristic replicates. *Truncocolumella citrina* was the outgroup.

From the second alignment, to state the relationship of *Rhizopogon* species collected in Europe with other Boletales, phylogenetic analyses were carried out, without including the ambiguous regions, by both parsimony (PAUP) and distance methods (TREECON). As in the previous parsimony analysis, characters were treated as unordered, gaps were treated as characters, the parsimony trees were constructed using heuristic methods and the branch robustness was estimated by bootstrap analysis of 250 heuristic replicates. *Gomphidius glutinosus* was the outgroup.

The analysis of the second alignment with the TREECON software was done using the nucleotide substitution rate calibration (Van de Peer *et al.*, 1996 a). This method calculates the evolutionary distance between sequences taking account of the relative substitution rate of the individual position in an alignment. Its uses an iterative process to: 1) calculate the distance matrix according to Jukes & Cantor (1969), 2) compute of sites variabilities, 3) construct substitution rate distribution and 4) derive new functions and distance estimation ("p" value). The equation derived from the resulting substitution rate distribution gives a more realistic relationship between sequence dissimilarity and evolutionary distance than equation previously available (Van de Peer *et al.*, 1996b). *Gomphidius glutinosus* was the outgroup.

RESULTS AND DISCUSSION

The distribution of the 16 morphological characters among the *Rhizopogon* species analysed in this study is summarized in Table 5.

The fifteen new sequences obtained in this study are deposited in the GenBank data base under the accession numbers given in Table 1. In the

Table 5. Morphological character states of the hypogeous taxa included in this study. Character and character states as described in Table 3.

Character	1111111 1234567890123456
<i>R.corsicus</i> , LG-Demoulin 4580	0011000012101010
<i>R.corsicus</i> , LG	0011000012101010
<i>R.luteolus</i> , BCC-MPM 2504	0011200011101021
<i>R.luteolus</i> , Sarasini 520	0011200011101021
<i>R.rocabrunae</i> , BCC-MPM 1995.o	1100000010110111
<i>R.rocabrunae</i> , BCC-MPM 1995.y	1100000010110111
<i>R.rocabrunae</i> , BCC-MPM 1862	1100000010110111
<i>R.roseolus</i> , BCC-MPM 1511	1000121110120010
<i>R.roseolus</i> , Sarasini 286	1000121110120010
<i>R.roseolus</i> , Sarasini 451	1000121110120010
<i>R.roseolus</i> , Sarasini 521	1000121110120010
<i>R.roseolus</i> , Sarasini 612	1000121110120010
<i>R. subcaerulascens</i> ⁽¹⁾	0011210113111170
<i>R.subsalmonius</i> , BCC-MPM 1653	0000120010011100
<i>R.subsalmonius</i> , Smith 65350	0000120010011100
<i>R.villosulus</i> , BCC-MPM 1800	1000311100101020
<i>Truncocolumella citrina</i> ⁽²⁾	1000???703100000

(1) Data according to Smith & Zeller (1966). (2) Data according to Smith & Zeller (1959)

first alignment an ambiguous part was generated (between the positions 150-175 bp) and was excluded from the analyses; 272 characters were included in PAUP (42 were informative) and TREECON analyses. In the second alignment, the alignment comprised 415 characters with two ambiguous regions (between the positions 150-175 bp and 332-415 bp) that were not included in the analyses: the PAUP input file contained 83 informative characters in unambiguously aligned parts.

Phylogenetic analyses under parsimony of the morphological data set of the 16 *Rhizopogon* species using *Truncocolumella citrina* as outgroup resulted in two equally parsimonious cladograms (tree length= 33; consistency index (CI) =0.697; retention index (RI) = 0.863; rescaled index (RC)= 0.601). Fig. 1 A shows one of the MPT (most parsimonious trees). Analysing the sequences of the 17 taxa, 14 MPT were generated (tree length=81; CI= 0.858; RI= 0.925; RC=0.788). The strict consensus tree is shown in Fig. 2A. Similar tree topologies were generated from the distance analyses and the neighbor joining method (Fig. 1B and 2B).

In the PAUP morphological tree (Fig. 1 A) the position of *Rhizopogon villosulus* is not well resolved (Sect. *Villosuli*) and *R. subcaerulescens* is the sister group of *R. corsicus* and *R. luteolus*. The five *R. roseolus* collections clade together as a sister group of the other *Rhizopogon* species from the Section *Rhizopogon*; although it is not well supported by bootstrap (60 %).

In the TREECON tree (Fig. 1B) *R. villosulus* clades together with the rest of *Rhizopogon* (100 % bootstrap).

In the molecular trees (Fig. 2 A and 2B) *R. roseolus* collections clade separately from the other *Rhizopogon* species with simple peridium (Sect. *Rhizopogon*). The species *R. subcaerulescens* (Sect. *Amylopogon*) and *R. villosulus* (Sect. *Villosuli*) clade together in a sister group of the clade formed for species of Sect. *Rhizopogon* other than *R. roseolus*. The branch including the five collections of *R. roseolus* was highly supported by bootstrap (85 % PAUP and 91 % TREECON) and the branch representing the group of *R. corsicus*, *R. luteolus*, *R. subsalmonius* and *R. rocabrunae* was strongly supported (93 % bootstrap in both analyses). Based upon these data Sect. *Rhizopogon* is paraphyletic. It is not a natural group within the genus *Rhizopogon*. The paraphyly of Section *Rhizopogon* is in agreement with Grubisha *et al.* (1997); although future work including more species and more sequence data is required before creating new sections. The chemical reactions of the gleba (KOH and Fe_2SO_4), characters introduced in the study of the genus *Rhizopogon* in Smith & Zeller (1966), are the only macroscopic characters that agree with the grouping of the species obtained through molecular analysis, as shown in Fig. 2.

The collections of *R. corsicus* and *R. luteolus* studied in these analyses were found to be very similar according to the molecular data set: under parsimony they clade together in a strongly supported clade (100 % of bootstrap). The distance matrix (data not shown) gives a value of 0.0 as mean distance between *R. corsicus* (LG-Demoulin 4580) and *R. luteolus* (BCC-MPM 25404). *R. corsicus*, a new species described in Moyersoen & Demoulin (1996) and accepted in Martín (1996), is assumed to be closely related to *R. luteolus*. Both have similar macroscopic characters, e.g. peridium with hard-bone consistency when dry. However, the peridium of *R. corsicus* turns reddish when handled, unlike the peridium of *R. luteolus*. Microscopic characters, mainly the type of peridium, allowed Martín (1996) to separate these taxa: in *R. corsicus* the peridium is formed of hyphal packets arranged in two directions; whereas in *R. luteolus* the peridium is formed of hyphal packets arranged in many different directions. The variation of the ITS2 region between the species was also very low (< 1%) which suggests that the morphological differences observed could be related to abiotic factors or stages of development, as was observed in *R. villosulus* (Martín *et al.*, 1997).

According to Fig. 2, the species limit is well defined for all species studied, except *R. subsalmonius*. Morphological studies of the two collections of *R. subsalmonius* showed no morphological difference between

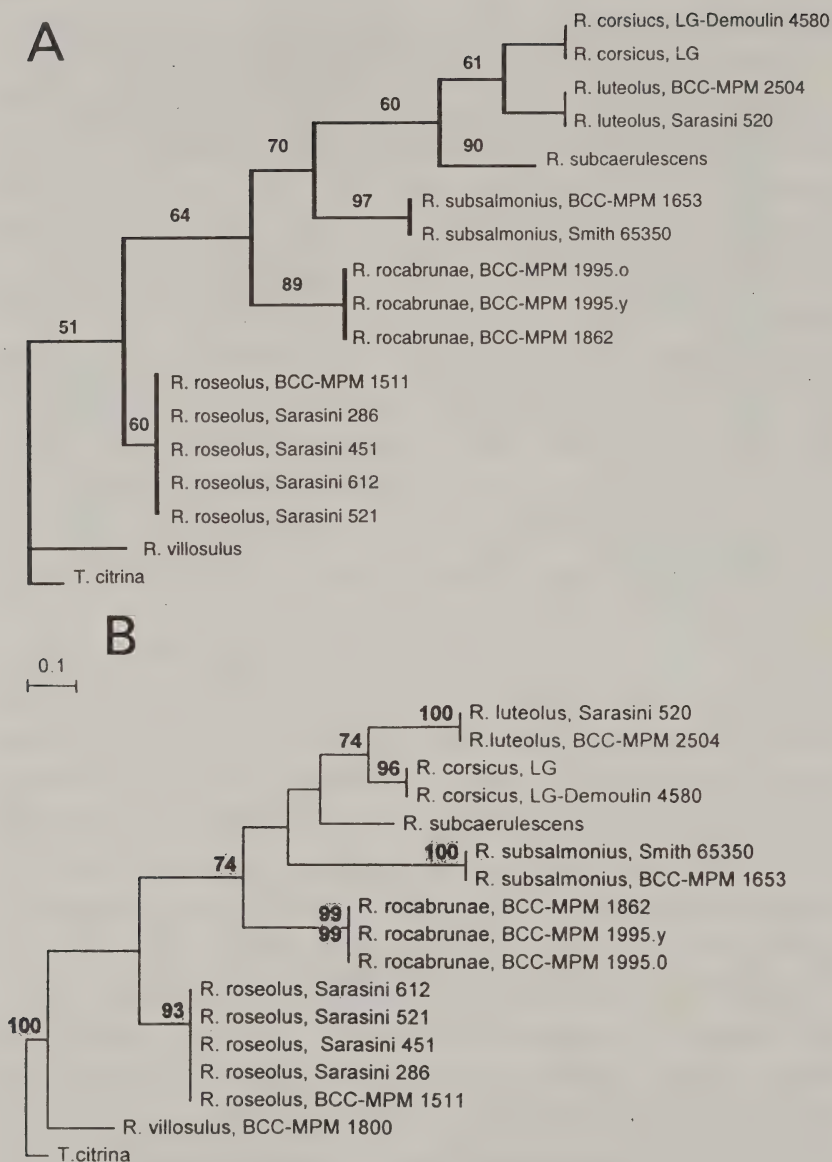


Fig. 1 Morphological analyses of specimens included in Table 1, as well as *Rhizopogon subcaerulescens* and *T. citrina*. Percentages from 1000 bootstrap replications are given on the branches. **A:** One of the two most parsimonious tree from heuristic analysis using PAUP 3.0. **B:** Tree constructed by neighbor joining from the distance matrix calculated according to Nei & Li (1979) using TREECON software.

them that would allow us to consider the possibility of two different taxa. However, the difference on a sequence level might be due to the biogeographic factors, one originates from Europe under *Pinus pinaster* and the other from North America under *Picea* sp. Smith & Zeller (1966) described five varieties of *R. subsalmonius* on the basis of the peridium colour changes when bruising and the peridium KOH reaction, and their study indicates that *R. subsalmonius* consists of more than one taxon. However, the variants they described could not be related to a specific host. More collections need to be included in future studies to resolve the genetic heterogeneity in this species.

R. rocabrunae collections, found in different kinds of forest (*Abies alba* or *Pinus sylvestris*), did not show intraspecific sequence divergence. The collections cluster together in a well supported clade (100 % bootstrap). Basidiomes with different degrees of maturation (BCC-MPM 1995.o and BCC-MPM 1995.y) belonging to the same collection not surprisingly show identical sequence data (mean distance 0.0).

Intraspecific sequence divergence was evident in *R. roseolus*, although all the samples cluster together in a well supported clade in the molecular analysis (85 % PAUP and 91 % TREECON). The finding that collections with the same spore volume, such as BCC-MPM 1511/Sarasini 612 or Sarasini 451/Sarasini 521 (Table 2), cluster in different branches is contradictory to the proposal by Gross, Runge & Winterhoff (1980) and supports our previous morphological studies (Martín, 1996). Gross *et al.* (1980) separate the basidiomes belonging to the *R. roseolus* complex, according to the spore volume in five groups: (A) *R. vulgaris* (Vitt.) M. Lange var. *vulgaris*, volume less than $22.5 \mu\text{m}^3$; (B) *R. vulgaris* (Vitt.) M. Lange var. *intermedius* Svrcek and *R. pumilionum* (Ade) Bataille, volume between 22.6 and $37.5 \mu\text{m}^3$; (C) *R. luteorubescens* A.H.Smith, volume between 37.6 to $52.5 \mu\text{m}^3$; (D) *R. rubescens* (Tul. & Tul.) Tul. & Tul. var. *rubescens* A.H. Smith and *R. roseolus* (Corda) Th. M. Fr., volume greater than $52.6 \mu\text{m}^3$; (E) specimens with many monosporic basidia and possessing abnormally large spores (more than $240\text{--}280 \mu\text{m}^3$), as well as spores similar to the previous taxa. However, in Martín (1996) the scatter diagram of spore length and spore width, based on 1458 samples belonging to the *R. roseolus* complex, supports the grouping of the taxa in a single species. The three collections from Italy clade together and separately from the other two collections from Spain suggesting the possibility of differences due to geographical origin, although this is not well supported by bootstrap values (59 %).

The parsimony analysis of the 15 *Rhizopogon* collections listed in Table 1 and the other Boletales from the GenBank (Table 4), yielded 100 most parsimonious trees (tree length= 288; CI= 0.510; RI= 0.734; RC=0.375). Fig. 3 shows one of the MPT. In the nucleotide substitution rate claiibration the value of parameter "p" was 0.68. Fig. 4 shows the tree constructed by neighbor-joining. In both figures, *Rhizopogon* is monophyletic and is the sister group of some of the *Suillus* species analyzed in Kretzer *et al.* (1996). Our data yielded trees similar to those in Grubisha *et al.* (1997) based on *Rhizopogon* collections, mainly from North America.

Truncocolumella citrina is a hypogeous fungus whose spores are quite similar to those of *Rhizopogon* species (Castellano *et al.*, 1989); however, in contrast to *Rhizopogon*, the gleba shows a prominent columella. The grouping of *T. citrina* among the *Suillus* species instead that with *Rhizopogon* is in accordance with cladograms based on the sequences of the large subunit nrDNA Grubisha (pers. com.).

Kretzer *et al.* (1996) based on molecular data (ITS1-5.8S-ITS2 rDNA) transfer the genus *Boletinus* Kalchbr and *Fuscoboletinus* Pomerl. & A. H. Smith into the genus *Suillus* Micheli ex S.F.Gray, because *Boletinus* and *Fuscoboletinus* were found not to be monophyletic as defined by Singer (1962; 1975) and Pormeleanu & Smith (1962) which based their classifications on the following characters: the presence or absence of clamp connections, the hymenophore configuration and the presence or absence of glandulae on the stipe.

Sutara (1987) in defining the limits of *Boletinus* and *Suillus* chooses the stipe covering as the most important diagnostic feature. *Boletinus* has a sterile stipe covered by a trichodermium, whereas *Suillus* has a fertile (caulobasidia) surface covered with a caulohymenium. He compares *Boletinus asiaticus* and *B. cavipes* stipe with many *Suillus* species, although he did not study *S. ochraceoseus* (form *Boletinus*). Dr. Roy Halling, who has recently examined a collection deposited in the NYBG herbarium, mentions (per. com.) that the stipe of *S. ochraceoseus* has no caulohymenium. Grouping of these three taxa in Fig. 3 and 4 may suggest that taxa with sterile stipe form a group apart from the other *Suillus* species. However, this morphological character is not reliable, according to the molecular data, since *S. spectabilis* (form *Boletinus/Fuscoboletinus* according to different authors) does not have a caulohymenium and it is in a separate clade from *S. asiaticus*, *S. cavipes* and *S. ochraceoseus*.

Based upon ITS2 the genus *Rhizopogon* is monophyletic and is the sister group of *Suillus*, which includes *Boletinus* and *Fuscoboletinus*. Both the

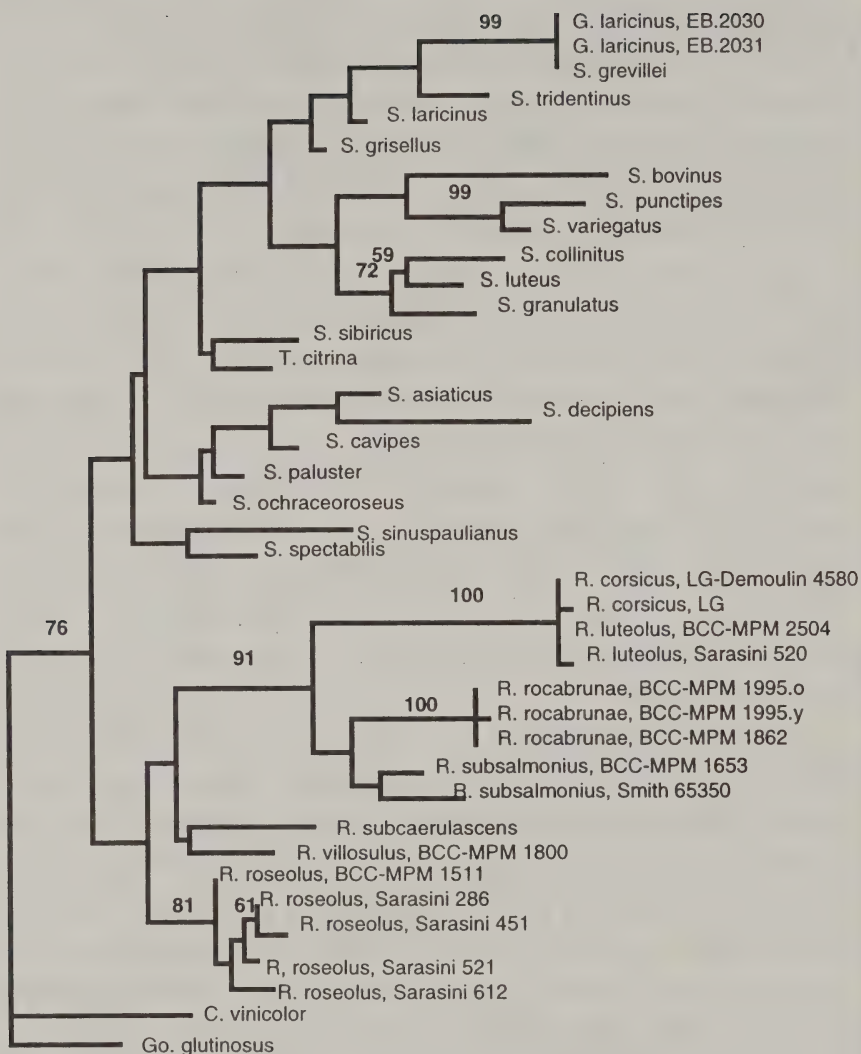


Fig. 3 Molecular analyses of specimens included in Table 1 and all the sequences retrieved from the GenBank included in Table 4. Strict consensus of 100 equally parsimony trees using PAUP 3.0. Percentages from 250 bootstrap replications are given on the branches.

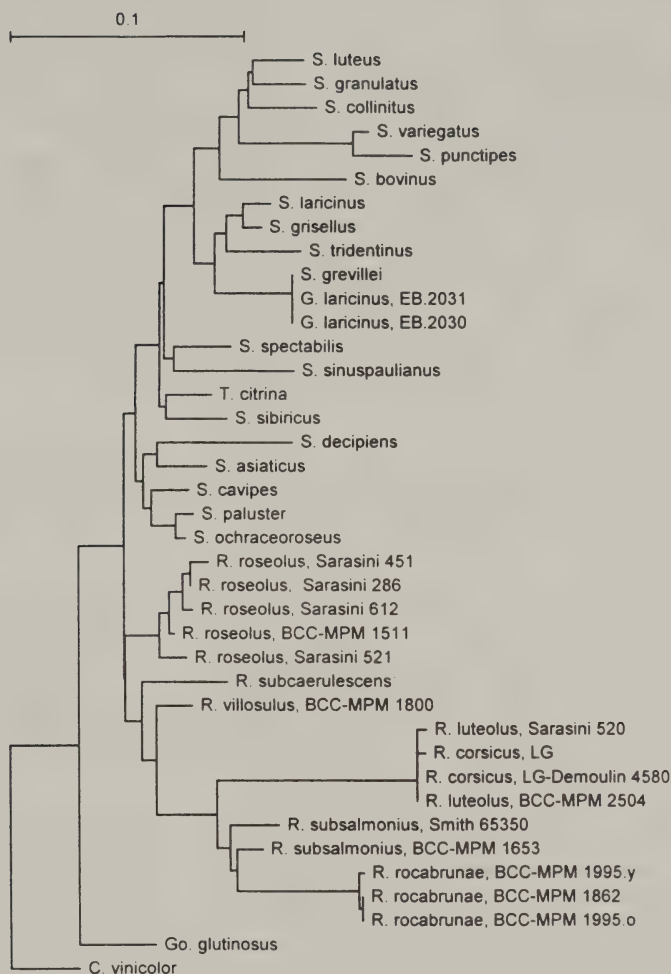


Fig. 4 Molecular analyses of specimens included in Table 1 and all sequences retrieved from the GenBank included in Table 4. Tree constructed by neighbor joining using the substitution rate calibration option (Van de Peer *et al.*, 1996 b) from TREECON software.

morphological trees and molecular trees support the conclusion that Sect. *Rhizopogon* is paraphyletic and if maintained *R. roseolus* must be excluded.

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New species, varieties and combinations in the genus *Flammulina*

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ABSTRACT -In order to facilitate a series of studies on the systematics of *Flammulina*, the basionym for the type species, *Agaricus velutipes*, is epitypified, two new species epithets and one varietal name are proposed (*F. populicola*, *F. rossica*, and *F. velutipes* var. *lupinicola*), and two new combinations are published (*F. elastica* [= *Agaricus elasticus*] and *F. elastica* f. *longispora* [= *F. velutipes* f. *longispora*]).

KEY WORDS: Agaricales, Tricholomataceae, enoki, *Populus*, *Salix*, *Lupinus*, Russia, USA, Canada.

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INTRODUCTION

In cooperation with several other researchers, the authors have investigated the systematics, biology and distribution of taxa in the genus *Flammulina* Karsten. Relationships among the taxa appear to be exceedingly complex, and the circumscription of the taxa requires detailed examination of many specimens. In order to provide a foundation for various subsequent papers, which attempt to resolve and explain the current situation, several new names are required. More complete discussions of these morphotaxa will be presented in the respective papers where mating systems, morphology, or molecular aspects will be detailed.

At this time, it would appear that *Flammulina* includes at least four major groups as well as some individual, poorly known taxa [i.e. *F. ferrugineolutea* (Beeli) Singer, *F. mediterranea* (Pacioni & Lalli) Bas & Robich]. In one Central to South American group, the lamellar trama is bilateral and the suprapellis is hymeniform [i.e. *F. callistosporioides* (Singer) Singer, *F. mexicana* Redhead et al. (1999)]. In another group from the southern hemisphere, the hymeniform suprapellis is combined with extraordinarily thick and gelatinized mediopellis [i.e. *F. similis* Horak, *F. stratosa* Redhead et al. (1999)], a third group (including the generic type species) is characterized by an ixotrichoderm of filamentous to branched and thorny ixohyphidia (Fig. 1) [i.e. *F. velutipes* (Curt.:Fr.) Singer (the type), *F. ononidis* Arnolds, *F. fennae* Bas, *F. elastica* (Lasch) *comb. nov.* - see below]. The fourth group is characterized simply by the hymeniform to somewhat hymeniform suprapellis (composed of broadly clavate, ten-pin-shaped, to sphaeropedunculate hyphal tips with scattered pileocystidia as they have otherwise unremarkable lamellar trama and mediopellis tissues (Figs. 8, 9) [*F. populicola* sp. nov., *F. rossica* sp. nov. (see below)].

Epitypification of *Agaricus velutipes* Curtis Flora Londinensis, 1777, fasc. 4, plate 70 [basionym for *Flammulina velutipes*]

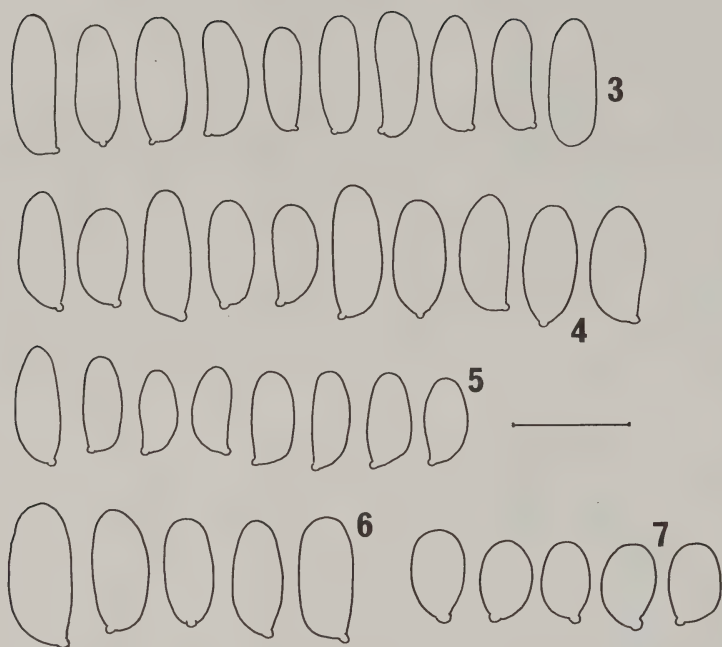
In order to segregate other taxa of *Flammulina*, whether already proposed (i.e. *F. fennae*, *F. ononidis*, etc.) or not (see below), it is necessary to securely establish the identity of the type species of the genus, particularly as we have discovered that several taxa are sympatric

in distribution with the type species. We accept the descriptions furnished by Bas (1983) and his choice of Curtis' plate 70 as lectotype (Bas p. 59). Epitypification is still required (ICBN 9.7) because additional taxa occur in England and essential distinguishing micromorphological information cannot be obtained from the text (in Latin and English) or illustrations (hand-colored lithograph) supplied by Curtis. It should also be noted that *Flora Londinensis* was published in seven fascicles of unnumbered plates but the general index cites fascicle 4, plate 70 for *A. velutipes*.

Of several collections examined by SAR from the vicinity of London, all represented the same morphological taxon, and accorded with the description furnished by Bas (1983). We propose the following specimen (Figs. 1, 2, 5) to serve as **epitype**: United Kingdom, England, Surrey, Ham, Towpath, January 3, 1995, coll. P.O. Thomas, originally determined by G.B. Butterfill, on tree by River Thames, K 28262 [!], spore print as TENN 56073, dikaryon and monokaryon cultures as CULTENN 7200.



Figs. 1-2. *Flammulina velutipes* var. *velutipes*, epitype material (K 28262). Fig. 1. Ixohyphidium. Fig. 2. Pileocystidium. Scale = ca. 10 μm .



Figs. 3-7. Basidiospores of *Flammulina* taxa. Fig. 3. Isotype of *Agaricus elasticus* (BPI). Fig. 4. Holotype of *F. rossica* (TENN 49489). Fig. 5. Epitype of *F. velutipes* var. *velutipes* (K 28262). Fig. 6. Paratype of *F. velutipes* var. *lupinicola* (NY - REH 6755). Fig. 7. Holotype of *F. populicola* (SFSU - DED 6115). Scale = ca. 10 μ m.

New taxa

Flammulina populicola Redhead & Petersen, sp. nov.

Figs. 7, 8

Pileus 15-33 mm lat., convexus, subumbonatus, substriatus, pruinosis vel subviscidus, luteo-brunneus vel aurantio-luteus. *Lamellae* adnatae, albae. *Stipes* 50-80 X 2-7 mm, fasciculatus, tenax, subpruinosis, subradicatus, luteo-brunneus. *Basidiosporae* 6.3-7.4 X 3.7-4.5 (av. 6.87 X 4.25) μ m, Q = 1.62, ellipsoideae, ovoideae vel obovoideae, hyalinae, inamyloideae, leves. *Cheilocystidia*, *pileocystidia* et *caulocystidia* lageniformia vel ventricosa. *Pileus* cuticula hymeniformi tectus. *Hypoderma* gelatinosum. *Hyphis* fibulatis. *Typus* lignicola in populo: DE Desjardin 6115. *Holotypus*: SFSU. *Isotypi*: TENN, DAOM 225915.

Holotype: United States: California, Sierra Co., Mill Peak Lookout Rd., elev. 6500', 8 June 1994, coll. DE Desjardin 6115, in dense clusters on fallen *Populus tremuloides* Michx. trunks soon after snow melt (SFSU). Paratype: United States: Alaska, Anchorage, Eid Ski Area, Abbott Rd., 61° 8.395' N, 149° 44.693' W, 17 Sept. 1995, coll. KW Hughes and RHP 8203, on *Populus* (TENN 54174).

Commentary:

Basidiomata of *F. populicola* can be considered similar to those of *F. velutipes* in appearance, although more frequently those of *F. populicola* are found in clusters or solitary on the ground (subradicating) at the base of trees. The basidiomata have a typically convex, dry to viscid, yellowish to orangish brown pileus, whitish lamellae, and a pruinose to velvety stipe, that darkens



Fig. 8. Pileipellis structure of the holotype of *Flammulina populicola*, showing projecting pileocystidia (P) and clavate palisade elements. Scale = ca. 10 μm .

from the base upwards (like *F. velutipes*) becoming blackish brown ultimately. Microscopically *F. populicola* is distinguishable by the combination of a hymeniform (to somewhat hymeniform) suprapellis (Fig. 8) (with or without limited apical or basal growths in some collections - as shown for *F. rossica*, Fig. 9) with typical pileocystidia (nearly always conspicuously projecting [Fig. 8], unlike those in *F. velutipes*, which may become embedded and/or collapse in slime), short (6-8.7 X 4-4.8 μm), ellipsoid basidiospores (Fig. 7) (with a spore Q = 1.51-1.64, av Q = 1.61), and otherwise unremarkable tramal tissues. As in virtually all other

Flammulina species, *F. populicola* produces abundant fusoid ventricose pleuro-, cheilo-, and caulocystidia, clamp connections, and smooth, nonamyloid, hyaline spores. It is widespread in western and central portions of North America (Canada, USA) and is also currently found in Europe.

The species epithet of *F. populicola* has been chosen because basidiomata are found most frequently on *Populus tremuloides*, although occasionally they occur on other hosts or substrates, as will be detailed in a later paper. There are considerable morphological variations in the taxon and hence problems occur in delimiting some collections.

The type collection has been chosen because morphologically, it is one of the forms most conspicuously distinguishable from either *F. velutipes*, *F. rossica* (see below), or other taxa. Moreover, not only are field-collected basidiomata available (as herbarium specimens) but there are also monospore isolates (used as compatibility testers) and in-vitro fruiting bodies (which have maintained their characteristic morphology).

Flammulina rossica Redhead & Petersen, sp. nov.

Figs. 4, 9

Pileus 20-50 mm lat., convexus, subumbonatus, substriatus, subviscidus, ochraceo-bubalinus. *Lamellae* adnexae vel adnatae, ochraceo-bubalinae. *Stipes* tenax, pruinosis, brunneus. *Basidiosporae* 7.4-11 X 3.8-4.5 (av. 8.88 X 4.21) μ m Q = 2.04, ellipsoideae vel ovoideae, hyalinae, inamyloideae, leves. *Cheilocystidia*, *pileocystidia* et *caulocystidia* lageniformia vel ventricosa. *Pileus cuticula* hymeniformi gelatinosi tectus. *Hypoderma* gelatinosum. *Hyphis* fibulatis. *Typus lignicola* in *Populo*: RHP 3232. *Holotypus*: TENN 49489. *Isotypus*: DAOM 225916.

Holotype: Russia: Primorski Terr., Dist. Ternai, Sichote Alin Biosphere Reserve, Meise, on *Populus* log, 12 Sept. 1990, RH Petersen 3232 (TENN 49489).

Paratype: United States: Alaska, Anchorage, Valley of the Moon Park, on log of ?*Betula*, 17 Sept. 1995, J Johnson & RHP 8195 (TENN 54170).

Commentary: *Flammulina rossica* basidiomata can be considered similar in appearance to those of *F. populicola* or *F. velutipes*, although more frequently they exhibit a very pale pileus (whitish at first glance, but actually pale yellowish ochraceous) with a typically convex, viscid pileus, very slightly pigmented (pinkish or yellowish) lamellae, and a pruinose to velvety stipe that darkens from the base upwards (like *F. velutipes*)



Fig. 9. Pileipellis structure of a paratype (TENN - RHP 8195) of *Flammulina rossica*, showing embedded pileocystidium (P) and irregularly clavate to moniliform palisade elements. Scale = ca. 10 μm .

becoming dark brown ultimately. Microscopically basidiomata are distinguishable by the combination of a hymeniform (comparable to that shown in Fig. 8 for *F. populicola*) to somewhat hymeniform suprapellis (with or without limited apical or basal growths in some collections, Fig. 9) with typical pileocystidia which may be scarce, and elongated (9.2-10.3 X 3.9-4.5 μm), ellipsoid (somewhat cylindrical at times) basidiospores (with a spore Q = 2.05-2.58, av. Q = 2.3), and otherwise unremarkable tramal tissues. As in virtually all other *Flammulina* species, *F. rossica* has abundant fusoid ventricose pleuro-, cheilo-, and caulocystidia, clamp connections, and smooth, nonamyloid, hyaline spores. It appears to have a trans-Beringian distribution as collections or cultures clustering with the type in some analyses have been examined

from eastern Russia and western North America (USA, Canada).

The type specimen was collected in far-eastern Russia, where there is a concentration of taxa morphologically distinguishable from *F. velutipes*, *F. populicola* (see above), or other taxa. Field-collected basidiomata are supplemented by monospore isolates (used as testers) and in-vitro fruiting bodies (which have maintained their characteristic morphology). *Flammulina rossica* basidiomata are found most frequently on either *Salix* or *Populus*, but can occur on other hosts or substrates, as will be detailed in a later paper. Basidiomata exhibit many variations and hence there are problems in identifying some collections.

Flammulina velutipes var. ***lupinicola*** Redhead & Petersen, var. nov.

Fig. 6

A *F. velutipes* basidiosporis *grandis* (av. $9.4 \times 4.47 \mu\text{m}$, $Q = 2.11$). *Typus lignicola* in *Lupino*: RHP 8078. *Holotypus*: TENN 55402. *Isotypus*: DAOM 225917.

Holotype: United States: California, Humboldt Co., Moonstone Lagoon, on dead *Lupinus arboreus* Sims on dunes, 15 Nov. 1996, RHP 8078 (with KW Hughes & DL Largent) (TENN 55402).

Paratype: United States: California, Humboldt Co., Samoa Dunes, 29 Nov. 1991, on *Lupinus* (roots and stems), RE Halling 6755 (NY).

Commentary: This North American infraspecific taxon can be distinguished by two parameters. First, basidiospores (Fig. 6) are larger ($7\text{--}14.8 \times 3.7\text{--}6.5 \mu\text{m}$; av. width $4.5\text{--}5.4 \mu\text{m}$) than those of the typical variety (Fig. 5). Secondly, it seems to be limited geographically (from southern to northern California) in an ecologically distinctive zone (in coastal dunes) largely on a specific host (*Lupinus arboreus*) native to the region. It is evidently only partially genetically isolated from the typical variety (*F. velutipes* var. *velutipes*; unpublished data). Comparison with another large-spored taxon (*F. ononidis*) on another leguminous host, *Ononis* (northern Europe) involves discussions of molecular, mating behaviour, physiological, and morphological data, and will be taken up in upcoming papers. The particular collection was selected as type of this ecologically distinctive taxon because of the availability of field material and derived monospore isolates used as tester strains for other experiments.

Flammulina elastica (Lasch) Redhead & Petersen, comb. nov. Fig. 3
 Basionym: *Agaricus elasticus* Lasch, Bot. Zeit. 15: 171. (1857).

Lectotype: *Agaricus elasticus* Lasch, in exsiccatae: Klotzschii Herbar. vivum mycol. sistens Fungorum per totam Germaniam crescentium collectionem perfectam. editio nova. Centuria V., cura Dr. L. Rabenhorst. Dresdae MDCCCLVII. Typis Car. Heinrich. 4. (BPI [!], and possibly other herbaria).

Commentary: This species has proven to be one of the most difficult to distinguish and to characterize. It was recognized at form rank by Bas (1983) using basidiospore quotients (average spore lengths plotted against average widths), but our observations and those of our colleagues (to be reported elsewhere) indicate that despite ambiguous subtle morphological data (cf. Fig. 3 [*F. elastica*] to Fig. 5 [*F. velutipes* var. *velutipes*], a distinctive species exists and is in need of a species name. The earliest available name at species rank that we have thus far been able to confirm microscopically (from syntype material from Europe, Fig. 3) is *Agaricus elasticus*. However, *Agaricus elasticus* was originally described as having a whitish pileus. The more commonly collected form, described by Bas as *F. velutipes* f. *longispora*, has a pigmented pileus, like *F. velutipes*. Hence, we recognize two forms under the species name, *F. elastica*.

Flammulina elastica* f. *longispora (Bas) Redhead & Petersen, comb. nov.

Basionym: *Flammulina velutipes* f. *longispora* Bas, Persoonia 12: 62. (1983).

Commentary: *Flammulina elastica* (both forms combined) can be characterized as a *F. velutipes* look-a-like, both macroscopically and microscopically, save for the longer basidiospores (8-11.5 X 3-4 μm , average Q 2.5-3). Basidiomata produce an ixotrichoderm as a suprapellis, composed of branched and unbranched ixohyphidia and scattered pileocystidia. Otherwise, basidiomata have unremarkable tramal tissues, and the standard fusoid ventricose pleuro-, cheilo-, and caulocystidia, clamp connections, and smooth, nonamyloid, hyaline spores characterizing *F. velutipes* and most of the genus. Thus far, *F. elastica* is known with certainty only from Europe but morphologically similar collections have been seen from North America also.

Only a few collections have been positively identified using several types of data (morphological combined with mating studies and/or molecular

data), but there appears to be an association primarily with the host genus *Salix*. The virtual genetic separation of *F. elastica* from *F. velutipes* is documentable but not from *F. rossica* (a species also often on *Salix*). However, morphological data distinguish the two, as does geography. A more complete discussion will be forthcoming in other papers.

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A NEW SPECIES OF HETEROCONIUM FROM A TROPICAL RAINFOREST

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ABSTRACT

Heteroconium decorosum R. F. Castañeda, Saikawa et Guarro *anam. sp. nov.* is described and illustrated. It was found on rotten pods of *Samanea samana* (Leguminosae) in an undisturbed rainforest in Cuba and is characterized by navicular to fusiform, curved, 3-7-septate, dark brown conidia. A comparative table of previously described species of *Heteroconium* is presented.

Key words: *Heteroconium*, *Lylea*, *Xenoheteroconium*, hyphomycetes, rainforest, Cuba.

INTRODUCTION

The genus *Heteroconium* Petrak (1949) is distinguished by macronematous, mononematous, unbranched conidiophores and monoblastic, terminal, determinate conidiogenous cells with schizolytic conidial secession. The conidia are euseptate, mid to dark brown, cylindrical to oblong, sometimes curved, arising in acropetal unbranched chains. The genera *Lylea* Morgan-Jones (1975) and *Xenoheteroconium* Bhat, W.B. Kendr. & Nag Rag (Bhat and Kendrick, 1993) are closely related to *Heteroconium* but the former has distoseptate conidia produced in unbranched chains on monoblastic determinate conidiogenous cells, and the latter has euseptate conidia formed in branched chains. Furthermore, *Xenoheteroconium* produces two kinds of propagules which originate from monoblastic, terminal conidiogenous cells, although sympodial proliferations are also observed in fertile areas which are already part of the conidial chains. In other ways the primary conidia secede late like "thallic disarticulation" as in some thallic-arthric fungi, although conidium ontogeny in *Xenoheteroconium* is clearly holoblastic.

In addition to the type species *Heteroconium citharexyl* Petr. (1949) (Ellis, 1971; Morgan-Jones, 1976), ten species have been described (Table 1): *H. chaetospora* (Grove) M.B. Ellis (1976), *H. solaninum* (Sacc. & Syd.) M.B. Ellis

(1976) (Morgan-Jones, 1976), *H. tetracoilum* (Corda) M.B. Ellis (1976), *H. lignicola* Panwar & Chauhan (1977) (as "*H. lignicolum*"), *H. indicum* Varghese & V.G. Rao (1980), *H. arundicum* Chowdhry (1980), *H. ponapense* Matsush. (1983), *H. queenslandicum* Matsush. (1989), *H. tropicale* R.F. Castañeda & W.B. Kendr. (1990) and *H. asiaticum* R. Chaudhary, C. Gupta & Kamal (1991). *Heteroconium queenslandicum* has undifferentiated conidiophores, and mono- and polyblastic conidiogenous cells. The conidia are 1-5-septate, 16-35 x 2.5-4 µm, pale brown, formed in acropetal branched chains. These characters are not congeneric with *Heteroconium* species, but a new combination is not proposed. *Heteroconium tetracoilum* has distoseptate conidia, and was transferred to *Lylea* as *L. tetracoila* Hol.-Jech. (1978) (as "*tetracoilum*").

Table 1. Comparative table of accepted species of *Heteroconium*.

Species	Conidiophores	Conidia
<i>H. arundicum</i>	Cylindrical, 4-8-septate, mid to dark brown, smooth, up to 100 µm long, 6-10 µm wide at the base.	Cylindrical to fusiform, 1-10-septate, smooth, 35-95 x 8-12 µm, mid to dark brown.
<i>H. asiaticum</i>	Cylindrical, slightly tapered at the apex, 2-3-septate, pale brown, smooth, 40-80 x 3.5-5.5 µm.	Cylindrical, tapered at the ends, pale brown, middle cells darker than the ends, smooth, 0-4-septate, 13-24 x 5-6.5 µm.
<i>H. citharexyl</i>	Cylindrical, 0-5-septate, smooth, 10-32 x 4-7 µm	Cylindrical to oblong, 1-10-septate, pale brown to brown, smooth, slightly constricted at the septa, 10-40 x 3-7 µm.
<i>H. chaetospora</i>	Cylindrical, 2-7-septate, pale brown, smooth, 30-60 x 3-5.5 µm.	Fusiform, slightly curved, 1-4-septate, very pale brown, 20-35 x 3-4 µm.
<i>H. indicum</i>	Cylindrical, 2-10-septate, reddish brown to dark brown, smooth, 45-150 x 8-10.5 µm.	Fusiform to cylindrical, 1-septate, pale brown to reddish brown, smooth, 23-42.5 x 8.5-10.5 µm.
<i>H. lignicola</i>	Cylindrical, mid to dark brown, smooth, up to 25 µm long, 4-5.5 µm wide.	Cylindrical, 1-4-septate, smooth, 13.5-32.5 x 5.5-8.5 µm.
<i>H. ponapense</i> *	Cylindrical with conical apex, 1-3-septate, brown, smooth, 15-30 x 4-5 µm.	Obclavate to ellipsoid, 1-septate, brown, smooth, 12-24 x 4-6 µm.
<i>H. solaninum</i>	Cylindrical, 1-3-septate, brown, smooth, 50-150 x 3-5 µm.	Cylindrical to fusiform, slightly tapered at the ends, 2-3-septate, pale olivaceous brown to pale brown, smooth, 12-24 x 4-4.5 µm.
<i>H. tropicale</i>	Cylindrical, tapered at the apex, 6-12-septate, brown below, pale brown above with a narrow, less pigmented zone at each septum, smooth, 160-230 x 5-7 µm.	Cylindrical to fusiform, tapered at the ends, 3-6-septate, slightly constricted at the septa, pale brown, smooth, 26-52 x 4-6 µm.

* Description in culture on V-8 juice agar

TAXONOMY

Heteroconium decorosum R.F. Castañeda, Saikawa et Guarro, anam. sp. nov.
 Etym.: *L. decorosum* meaning elegant and pretty. Figs. 1, 2

Ad fungos conidiales, hyphomycetes pertinens. Coloniae in substrato naturali effusae, pilosae, nigrae. Mycelium partim superficiale et partim in substrato immersum. Hyphae septatae, ramosae, laeves, 2-3 µm diam. Conidiophora macronemata, mononemata, cylindrica ad usque leviter subulata, 4-7-septata, erecta, recta, non-ramosa, 45-110 x 8-10 µm, levia, atrobrunnea infra, brunnea supra. Cellulae conidiogenae monoblasticae, terminales, determinatae, brunneae, 12-15 x 5-8 µm, laeves. Conidiorum secessio schizolytica. Conidia navicularia, lata fusiformia usque ad obclavata interdum sigmoidea vel curvata, blastocatenata, holoblastica, levia, raro verrucosa; conidia primaria 5-7-septata, utrinque truncata, atrobrunnea sed brunnea vel dilute brunnea ad apicem, 32-50 x 8-10 µm; conidia secundaria obclavata, sigmoidea ad usque curvata, infra truncata, supra rotundata, 3-6 (plerumque 3-4)-septata, 20-30 x 3-5 µm, brunnea, sed dilute brunnea ad cellula apicali et basali. Teleomorphosis ignota.

Holotypus: INIFAT C97/38-1, Santiago de Las Vegas, Cuba. Isotypus: MUCL 41014.

Substratum: *In leguminis putrecentibus Samanea samantis* Merr.

Habitat: *In sylva pluvialis*, Pozo del Cura, Escambray, Cienfuegos, Cuba. Legit R.F. Castañeda, 27-I-1997.

Conidial fungi, hyphomycetes. Colonies on the natural substratum effuse, hairy, black. Mycelium superficial and immersed. Hyphae septate, branched, smooth-walled, 2-3 µm diam. Conidiophores macronematous, mononematous, cylindrical to slightly subulate, 4-7-septate, erect, straight, unbranched, 45-110 x 8-10 µm, smooth, dark brown below, brown above. Conidiogenous cells monoblastic, terminal, determinate, brown, 12-15 x 5-8 µm, smooth. Conidial secession schizolytic. Conidia navicular, broad fusiform to obclavate, sometimes sigmoid to curved, blastocatenate, holoblastic, smooth-walled, rarely verrucose; primary conidia 5-7-septate, truncate at the ends, dark brown, brown to pale brown at the apex, 32-40(-50) x 8-10 µm; secondary conidia obclavate, sigmoid to curved, truncate below, rounded above, 3-6 (mostly 3-4)-septate, 20-30 x 3-5 µm, brown, pale brown ends. Teleomorph unknown.

Holotype: INIFAT C97/38-1, Santiago de Las Vegas, Cuba. Isotype: MUCL 41014.

Substrate: On rotten pod of *Samanea samans* Merr.

Habitat: In undisturbed rainforest, Pozo del Cura, Escambray, Cienfuegos, Cuba. Col. R.F. Castañeda, 27-I-1997.

Heteroconium decorosum slightly resembles *H. arundicum* and *H. citharexyli* in the primary conidia pigmentation and number of cells, but *H. arundicum* has cylindrical to fusiform, 35-95 x 8-12 µm, mid to dark brown conidia and *H. citharexyli* has cylindrical to oblong, 10-40 x 3-7 µm, pale brown to brown conidia. The combination of characteristics present in *H. decorosum* distinguishes this species from the other two.

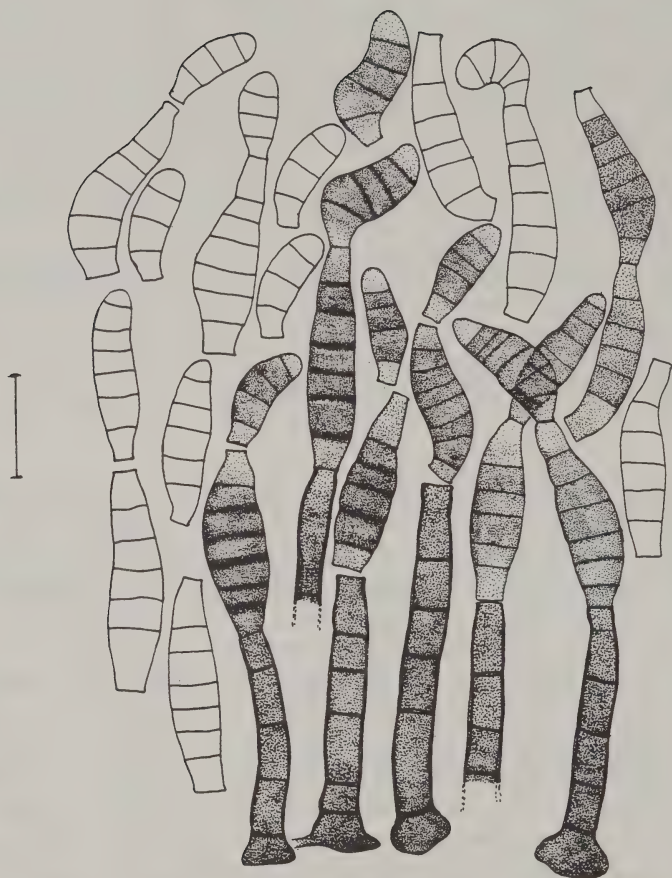


Fig. 1. *Heteroconium decorosum* INIFAT (97/38-1). Conidiophores and conidia.
Bar = 10 μ m.

ACKNOWLEDGMENTS

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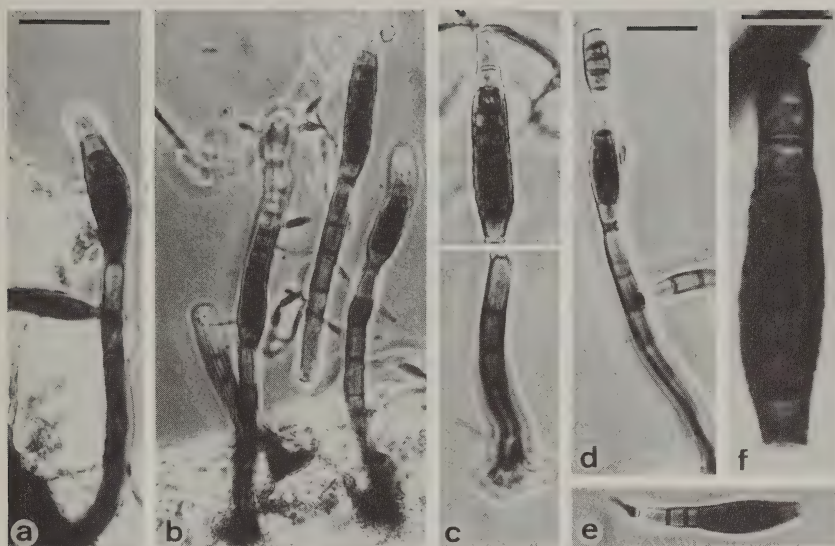


Fig. 2. *Heteroconium decorosum* INIFAT (97/38-1). Conidiophores and conidia. Bars: a, b, c = 20 µm; d, e = 20 µm; f = 10 µm.

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MYCOTAXON

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CONICOMYCES NASSENSIS, A NEW SYNNEMATOUS FUNGUS FROM THE NASS RIVER VALLEY, BRITISH COLUMBIA¹.

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Abstract

The new hyphomycete species *Conicomycetes nassensis* is described based on a specimen collected on *Pinus contorta* wood in the Nass River valley of British Columbia, Canada. The species produces black synnematosus conidiomata up to 3000 μm tall, with a terminal concave conidiogenous zone of intermixed sterile hyphae and percurrently or sympodially proliferating conidiogenous cells, and a yellow slimy mass of 11-21-septate phragmoconidia, 96-116 $\times$ 4-5 μm , with a single terminal appendage about 1/2 the length of the conidium body. The species is compared with the two other species currently classified in this genus.

Key words: anamorph taxonomy, *Morrisographium*, hyphomycete, biodiversity

Introduction

The anamorph genus *Conicomycetes* R. C. Sinclair, Eicker and Morgan-Jones (1983) was described for *C. transvaalensis*, a lignicolous dematiaceous hyphomycete with determinate, synnematosus conidiomata with a concave conidial hymenium, holoblastic conidiogenous cells, a slimy conidial mass, and hyaline phragmoconidia with a single, apical cylindrical appendage. Shortly thereafter, Illman and White (1985a) described *C. contortus*, differing in the shape and dimensions of the conidia. Nag Raj (1993), in his revision of coelomycetes with appendaged conidia, redescribed and illustrated both species.

During a field trip to northern British Columbia in October 1998, an abundant fruiting of a synnematosus fungus was collected in the Nass River valley. The collection was readily assignable to *Conicomycetes* but differed from the two previously described species. It is described as a new species here.

¹ Contribution number 981369.1248 from the Eastern Cereal and Oilseed Research Centre.

Materials and Methods

The fungus was collected in a flat *Pinus contorta* plantation with limited undergrowth. Synnemata of the fungus were abundant at the time of collection, growing on fallen, decorticated, brown rotted logs with dry, weathered surfaces. Synnemata were found on exposed wood, but were more abundant in cracks in the logs. Wet conidial masses were transferred to 2% malt extract agar with 100 mg/L tetracycline within six hours of collection, but the conidia failed to germinate and no cultures were obtained.

The morphological description is based on examination of material mounted in 85% lactic acid or tap water. Means $\pm$ standard error are based on 25 measurements.

Taxonomy

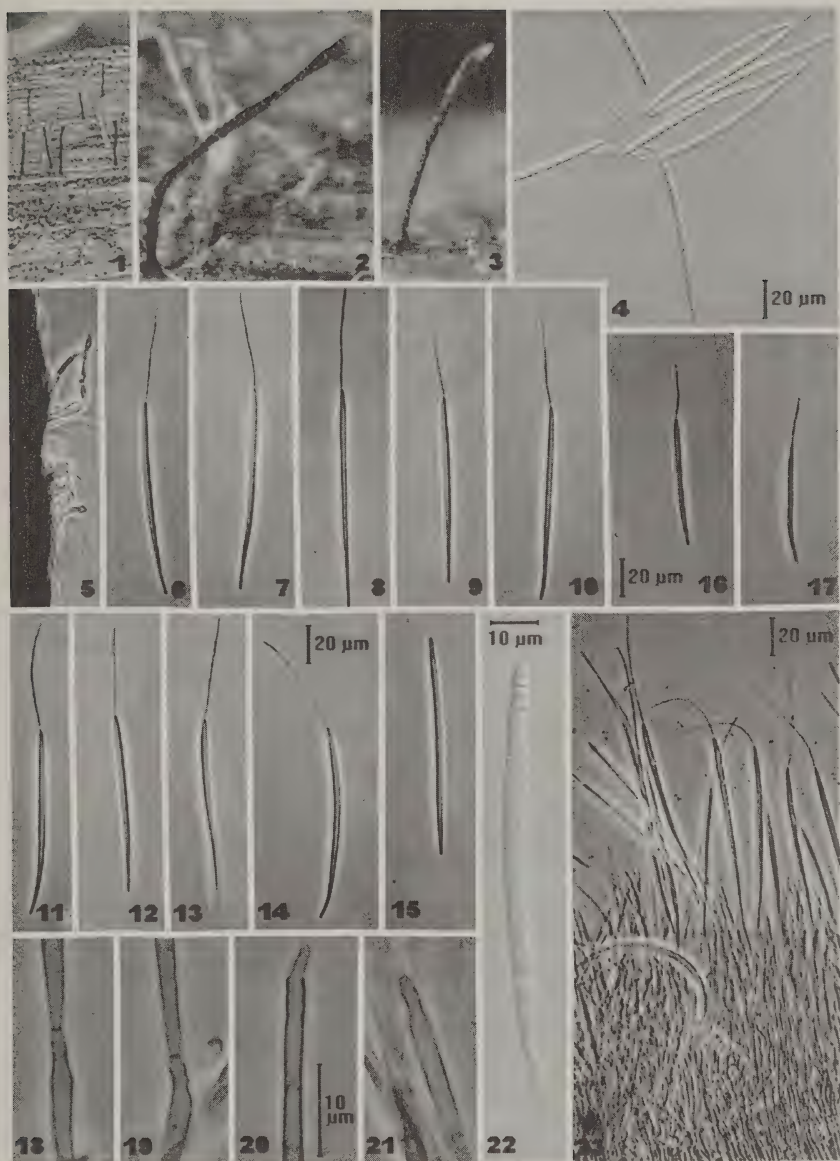
Conicomycetes nassensis Seifert, sp. nov.

Figs. 1-15, 18-23.

Conidiomata synnemata, determinata, atra, cylindrico-captitata, 400-3000 μm alti, stipites 25-75 μm lati, hirsuti. Hyphae stipitis parallelae, interiores hyalinae, exteriores fuscae, marginalis brunneae. Capitulum expansum, cupulatum. Conidiophora semel monochasialia, cellulae conidiogenae hyphis sterilibus 75-120 μm longis intermixtae. Cellulae conidiogenae 13-18 $\times$ 1.5-2.5 μm , percurrenter vel sympodialiter proliferantes. Massa conidiorum apicalis mucida, flava, saepe sursum acutata, 50-250 μm alta, 75-200 μm lata. Conidia 96-116 $\times$ 4-5 μm , 11-21 septata, fusoidea vel subclavata, ad apicem appendiculata, appendix 48-66 μm longus, 1 μm crassus, cylindricus. Holotypus in ligno Pini contortae, leg. K. A. Seifert no. 638, Canada, British Columbia, circa km 132, Hwy. 37, 19 Oct. 1998 in herb. DAOM no. 225918.

Synnemata 400-3000 μm tall, scattered to gregarious, emerging directly from the wood and lacking a basal stroma or tomentum, the stipe black, cylindrical and 25-75 μm wide, usually hirsute at the base, smooth in the upper 1/8-1/4, sometimes entirely smooth, the stipe expanding into a divergent, concave conidial hymenium up to 150 μm wide. *Hyphae of stipe* in three zones; the inner zone of parallel, subhyaline hyphae 1-1.5 μm wide, with thin walls and occasional anastomoses; the outer zone comprised of parallel, brown hyphae 2-3.5 μm wide with slightly thickened walls; marginal hyphae brown, projecting 20-50 μm at more or less right angles, 3.5-4.5 μm wide,

Figs. 1-15, 18-23, *Conicomycetes nassensis*, holotype. 1. Habit of synnemata in the field (photo S.A. Redhead). 2-3. Individual synnemata. 4. Group of conidia with tangled appendages, in water (DIC). 5. Marginal hyphae of stipe (phase contrast). 6-15. Conidia in lactic acid (phase contrast). 18-21. Conidiogenous cells, showing evidence of percurrent and sympodial proliferation (phase contrast). 22. Single conidium in



water, showing septation (DIC). 23. Part of cupulate 'hymenium' showing conidia emerging among the layer of sterile hyphae that surmounts the conidiogenous cells (phase contrast). **Figs. 16-17, *Conicomyces contortus*, holotype.** Conidia at same magnification as Figs. 6-15, allowing comparison between the two species (phase contrast).

straight, curved or sinuous, frequently septate, with slightly thickened walls, less pigmented near their ends. *Conidiogenous hymenium* divergent, the margin comprised of a fringe of sterile hyphae that are a continuation of the outer hyphae of the stipe, which become subhyaline near the tip. *Conidiophores* continuations of the inner hyphae of the stipe, lining the concave inner surface of the hymenium, with one or two monochasial branches, usually with single lateral conidiogenous cells, intermixed with long, subhyaline, sterile hyphae 75–120 μm long, 2.5–3.5 μm wide and tapering and becoming less pigmented towards the apex. *Conidiogenous cells* usually single and lateral or terminal on the conidiophore, 13–18 μm long, hyaline, cylindrical to slightly clavate, 1.5–2.5 μm wide at the widest zone, proliferation apparently mostly percurrent, sometimes sympodial, resulting in a cylindrical to irregularly shaped zone 2.5–5 μm long that is somewhat narrower than the rest of the cell, about 1.5 μm wide, terminating in a conidiogenous aperture about 1–1.5 μm wide. *Conidial mass* slimy, yellow, conical to flame shaped, about 75–200 μm wide, 50–250 μm tall, sometimes appearing slightly striate when dry. *Conidia* 96–116 ($\bar{x}$ 106.5 $\pm$ 0.9) $\times$ 4–5 μm (exclusive of the appendage), L/B ca. 25–30:1, (5–)11–21-septate, the cells of unequal length, hyaline, the body narrowly clavate, straight, gently curved, or slightly sinuous, broadest above the middle, with a flattened base 1–1.5 μm wide, and a rounded apex, the appendage single, aseptate, cylindrical, hyaline, 48–66 μm long, about 1 μm wide, straight or coiled, often tangling with appendages of adjacent conidia; some conidia (less than 5%) appear to lack appendages, but they may be folded or adpressed to the main body of the conidium.

Holotype: Canada, British Columbia, km. 132, Hwy. 37, 55° 53' 5.9" N, 128° 59' 54.4" W, alt. 210 m, on decorticated *Pinus contorta*, leg. K. A. Seifert no. 638, 18 October 1998 (DAOM 225918).

Other material examined: *Conicomyces transvaalensis*, slide ex holotype (DAOM 189752). *Conicomyces contortus*, holotype (DAOM 177281), authentic specimens from Waterton National Park, Alberta (DAOM 176849, 176967).

Discussion

Conicomyces nassensis is characterized by the production of dark synnemata with hirsute stipes on *Pinus* wood, yellow conidial masses sitting in a concave conidial hymenium, apparently percurrently proliferating conidiogenous cells intermixed with sterile hyphae, and 11–21-septate phragmoconidia, 96–116 $\times$ 4–5 μm with an apical hyaline appendage about 1/2 the length of the conidium body. The septa of the conidia are most readily seen in water mounts. The species is similar to *C. contortus* (figs. 16–17), known primarily from wood of *Populus* spp. in

Canada, the northern United States and the eastern Rockies, which also has hirsute synnemata but smaller conidia of a similar shape, $63\text{--}90 \times 3.5\text{--}4.5 \mu\text{m}$ with the appendage $20\text{--}30 \mu\text{m}$ long. The dimensions of the synnemata, conidia and appendages of the two species scarcely overlap, with those of *C. nassensis* being consistently larger (figs. 6–15). *Conicomycetes transvaalensis* has synnemata with smooth stipes and distinct black apical setae supporting the conidial mass. Its conidia are $154\text{--}175 \times 6\text{--}7 \mu\text{m}$, with an appendage $30\text{--}84 \mu\text{m}$ long, longer and broader than the conidia of *C. nassensis*.

The conidia of *C. nassensis* are readily liberated in water, and groups of conidia are frequently held together by tangled appendages. This phenomenon was also noted by Illman & White (1985a) for *C. contortus*, and is assumed to relate to the dispersal of these organisms by water films (cf. Bandoni & Koske 1974).

Proliferation of the conidiogenous cells of *C. nassensis* was not studied by electron microscopy, but appears to occur either percurrently or sympodially, a combination increasingly recognized in hyphomycetes. Both Sinclair *et al.* (1983) and Nag Raj (1993) described the conidiogenous cells of *C. transvaalensis* as phialides, whereas percurrent proliferation of conidiogenous cells of *C. contortus* was observed by Nag Raj (1993). This apparent plasticity in proliferation, which at one time would have suggested these three species be separated into different genera, cannot be considered significant at the generic level in light of the other distinctive characters shared by these three fungi.

Species concepts in *Conicomycetes* and the similar genus *Morrisographium* M. Morelet are so far based on micromorphology and substrate preferences. Separation of the two genera is debatable; both have dark, determinate, cupulate synnemata, with slimy, hyaline phragmoconidia but the conidia of *Morrisographium* species lack appendages. There are also hints that slightly different ecological roles may be at play. All but one of the seven species currently included in *Morrisographium* (Illman & White 1985b) occur sparsely on bark, whereas species of *Conicomycetes* produce more abundant fruitings on exposed wood. My unsuccessful attempts to culture *C. nassensis* and several species of *Morrisographium* on 2% malt extract agar suggest that the species do not culture readily, an observation also noted by Illman & White (1985a). Furthermore, our attempts to employ rapid DNA isolation kits designed for minute amounts of material of *Morrisographium* spp., followed by direct amplification of the small subunit nuclear rDNA (18S), have also been unsuccessful. Thus, any attempts to demonstrate the phylogenetic relationships (and possible synonymy) of these two genera, and to develop biological and phylogenetic species concepts, will be a challenge.

Acknowledgements

I am grateful for the company of Dr. Scott Redhead on the field trip on which this fungus was collected and for the habit photograph of the fungus. Presubmission reviews were provided by John Bissett, Stanley J. Hughes and George P. White. Walter Gams kindly corrected the Latin diagnosis.

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MYXOMYCETES FROM A SEASONAL TROPICAL FOREST ON THE PACIFIC COAST OF MEXICO

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ABSTRACT

We conducted the first inventory of myxomycetes from a seasonal tropical forest. We present an annotated species list for the 41 taxa found at the Chamela Biological Station (Mexico) and illustrate the richness of myxomycete species in this kind of forest. *Cribraria cancellata* var. *fusca*, *Diachea silvaepluvialis*, *Physarum javanicum*, *Ph. viride* var. *aurantium* and *Stemonitopsis* aff. *gracilis* are new records for Mexico. SEM photographs of spores that reveal features not previously described in some species are included. A brief description and discussion of the patterns of distribution of selected species also are provided.

Key words: Biodiversity, Chamela, México, myxomycetes, plasmodial slime molds, seasonal tropical forest.

RESUMEN

Se realiza el primer inventario de los myxomycetes de un bosque tropical caducifolio. Se aporta una lista comentada de las 41 especies encontradas en La Estación Biológica de Chamela (México) que ilustra la riqueza en especies de este tipo de bosque. *Cribraria cancellata* var. *fusca*, *Diachea silvaepluvialis*, *Physarum javanicum*, *Ph. viride* var. *aurantium* y *Stemonitopsis* aff. *gracilis* son nuevos registros para México. Se incluyen fotografías al MEB de las esporas de algunas especies, que revelan caracteres no descritos previamente. Se lleva a cabo una breve discusión sobre los patrones de distribución geográfica de algunas especies.

INTRODUCTION

Plasmodial slime molds (myxomycetes) are eukaryotic, phagotrophic bacterivores usually present in terrestrial ecosystems. Worldwide, there are approximately 900 recognized species, but the major inventories and publications have focused on temperate and boreal regions. It is generally accepted that the greatest biological diversity is found in the tropics, but many areas are still poorly studied, and scanty and infrequent biotic surveys do not permit accurate estimates of tropical myxomycete diversity.

Our interest in tropical areas centers on the Neotropical regions. Biogeographically, Mexico is remarkable for its biotic richness, with more than 20,000 species of plants recognized, of which approximately 9,300 are endemic (RZEDOWSKI, 1991). Mexico is also a center of diversity for some groups of plants (DAVIS *et al.*, 1997), and because of its transitional features between temperate and tropical regions, Mexico is a mosaic of vegetational zones.

Almost 40% Mexico's territory is tropical, comprising four main vegetation types (RZEDOWSKI, 1978). Among them, tropical deciduous forest (in the terminology of RZEDOWSKI (1978), deciduous low forest *sensu* MIRANDA & HERNANDEZ (1963), or deciduous seasonal forest *sensu* BEARD (1955)) is the most abundant and characteristic vegetation type of the Pacific coast. It extends almost continuously from the south of Baja California and Sonora to Chiapas.

In spite of its biological interest, the tropical deciduous forest is one of the lesser studied ecosystems in the world. Myxomycetes from its plant communities are practically unknown, and only five species have been reported previously (VILLARREAL, 1990). In this paper, we present the first inventory of myxomycetes for this forest type.

STUDY AREA

The Chamela Biological Station is situated 2 km inland from the Pacific coast in the state of Jalisco (Mexico), between 19°29'-19°34' N and 104°58'-105°04' W (Fig. 1). It contains 1,600 ha of well preserved tropical deciduous forest. The landscape is one of low hills (50-100 m) with convex slopes (26° on average), and elevations range between 70-580 m. The climate has a strong seasonality, with an annual rainfall of 740 mm, 80% of which falls between July and November (BULLOCK, 1986). This pattern gives the forest two highly contrasting appearances, desolate and gray in the dry season and exuberant and green in the rainy season. As such, it resembles an intricate mosaic of plants from wet and arid zones. The mean annual temperature is 24.9°C, with a low of 20°C (January) and a high of 27°C (August). The vegetation changes from the hills to the valleys. The former is tropical deciduous forest, which is the main plant community in the reserve area (BARAJAS MORALES & PÉREZ JIMÉNEZ, 1990); the valleys have tropical subdeciduous forest (semi-evergreen seasonal forest *sensu* BEARD, 1955). The high floristic diversity of the reserve and its numerous endemic plants are two of its more distinctive features (RZEDOWSKI, 1978, 1991). More than 200 tree species have been recorded from the area (LOTT, 1985). Trees of low size

(between 5-15 m) predominate (RZEDOWSKI & EQUIHUA, 1987), shrubs are very abundant, and lianas are frequent in the vicinity of the coasts, but columnar and candelabrum-shaped cacti are also common (TREJO, 1996). Another important feature of this plant community is the almost complete loss of leaves from the trees during 5-8 months. Unfortunately, the region has been subjected to intense land transformation, and the extent of deforestation increases day by day.



Fig. 1. Chamela Biological Station. Geographical location.

MATERIAL AND METHODS

This preliminary exploration was made in September 1995, at the end of the rainy season. A total of 81 samples was collected on a random collecting trip, and fructifications of all the specimens were taken directly from the field; moist chamber cultures were not prepared. As the area is a Biological Reserve, the samples were limited to those strictly necessary for a correct identification of the species, and obviously the number is not an expression of the abundance of each species. The specimens are preserved at the herbarium TLXM (Centro de Investigación en Ciencias Biológicas, Universidad Autónoma de Tlaxcala, México) with the collection numbers of M. Rodríguez-Palma (e.g., TLXM sub RP 2181), and duplicates of some specimens are kept at MA-Fungi (Real Jardín Botánico de Madrid, España) and at the herbarium of the Estación Biológica de Chamela.

For the SEM studies, the critical point technique was employed and the specimens were examined by a Jeol T 330 A scanning electron microscope at 10-15 kV.

SPECIES LIST

Order CERATIOMYXALES

Ceratomyxa fruticulosa (O.F. Müll.) T. Macbr.

On dead wood, TLXM sub RP 2181 (MA-Fungi 35101), TLXM sub RP 2211.

Order LICEALES

Cribraria cancellata (Batsch) Nann.-Bremek. var. *cancellata*

On dead wood, TLXM sub RP 2191 (MA-Fungi 35112).

The spores of this specimen are smaller (4.5-5.5 mm) than in the descriptions provided by MARTIN & ALEXOPOULOS (1969) and NANNENGA-BREMEKAMP (1991).

Previously reported from Mexico as *Dictydium cancellatum* (Batsch) T. Macbr. (OGATA et al., 1994).

Cribraria cancellata var. *fusca* (Lister) Nann.-Bremek.

On dead wood, TLXM sub RP 2199a (MA-Fungi 35119).

This is the first record for Mexico.

Cribraria tenella Schrad.

On dead wood, TLXM sub RP 2144 (MA-Fungi 35076), TLXM sub RP 2146 (MA-Fungi 35078), TLXM sub RP 2199b (MA-Fungi 35120), TLXM sub RP 2213 (MA-Fungi 35131).

The specimens studied show a considerable variation in the dimension and structure of the peridium. In RP 2199b and RP 2144, it remains as a deep calyculus, covering ca. 1/2 of the base and possessing a smooth margin; in RP 2146, the upper margin has short ribs, and in RP 2213, the peridium is reduced to ribs and a basal disc that covers ca. 1/7 of the sporotheca. In all cases, the concentration of calcic granules is most evident on the outside of the peridial nodes (Fig. 2). Under the light microscope (LM), the spores of this species are described as "almost smooth" (MARTIN & ALEXOPOULOS, 1969), "nearly smooth to faintly verrucose" (FARR, 1976), or "densely, minutely warted" (NANNENGA-BREMEKAMP, 1991), but by SEM the spores bear an

irregular, broken reticulum (Figs. 3-4), with the ridges on the spore surface formed by fused bacula (cristate reticulate type in the terminology of RAMMELOO, 1974, 1975).

This is the second record for Mexico. Previously reported from the Gulf Coast in Veracruz (OGATA, 1992; OGATA et al., 1996).

***Cribraria violacea* Rex**

On dead wood, TLXM sub RP 2147 (MA-Fungi 35079).

The spore size in this specimen is slightly smaller (5.5-6.3 μm) than that reported by MARTIN & ALEXOPOULOS (1969) and NANNENGA-BREMEKAMP (1991).

***Lycogala exiguum* Morgan**

On dead wood, TLXM sub RP 2148 (MA-Fungi 35080, 35136).

This is apparently an uncommon species but related to the more frequently reported *L. epidendrum* (L.) Fr. Nevertheless, in our experience, this species seems more frequent in tropical zones. In Mexico, it has been found rarely in *Abies-Pinus* forest at 3,350 m alt. (RODRÍGUEZ-PALMA, 1996), and more frequently in tropical semideciduous (OGATA, 1992) and deciduous forests (personal observations).

Order ECHINOSTELIALES

***Clastoderma debaryanum* A. Blytt**

On bark of tree and dead wood, TLXM sub RP 2145 (MA-Fungi 35077), TLXM sub RP 2210.

Order TRICHIALES

***Arcyria cinerea* (Bull.) Pers.**

On dead wood, bark, TLXM sub RP 2155b, TLXM sub RP 2167 (MA-Fungi 35093), TLXM sub RP 2205 (MA-Fungi 35126), TLXM sub RP 2212 (MA-Fungi 35130).

***Arcyria denudata* (L.) Wettst.**

On dead wood, TLXM sub RP 2180a, TLXM sub RP 2180c, TLXM sub RP 2180d, TLXM sub RP 2195 (MA-Fungi 35114).

***Hemitrichia calyculata* (Speg.) M.L. Farr**

On dead wood, TLXM sub RP 2182 (MA-Fungi 35102, 35103, 35104, 35137), TLXM sub RP 2204 (MA-Fungi 35125).

***Hemitrichia serpula* (Scop.) Rostaf. ex Lister**

On dead wood, TLXM sub RP 2183 (MA-Fungi 35105).

***Perichaena chrysosperma* (Curr.) Lister**

On bark, TLXM sub RP 2143, TLXM sub RP 2194 (MA-Fungi 35113), TLXM sub RP 2215 (MA-Fungi 35132, 35133).

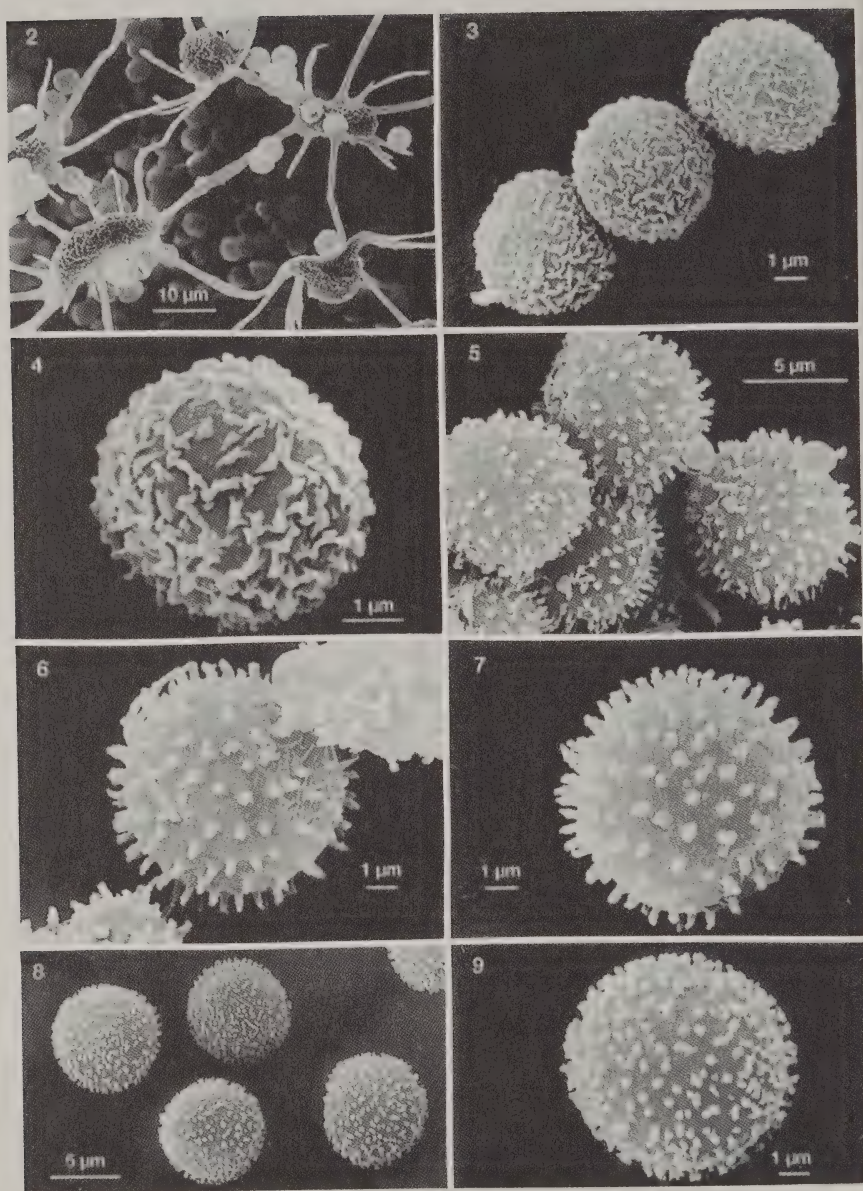
Order PHYSARALES

Craterium leucocephalum* (Pers. ex J.F. Gmel.) Ditmar var. *leucocephalum

On dead branch and living leaves, TLXM sub RP 2160 (MA-Fungi 35088), TLXM sub RP 2161 (MA-Fungi 35089), TLXM sub RP 2162 (MA-Fungi 35090), TLXM sub RP 2168 (MA-Fungi 35094), TLXM sub RP 2173.

***Diachea bulbillosa* (Berk. & Broome) Lister**

On dead leaves, TLXM sub RP 2177a (MA-Fungi 35100), TLXM sub RP 2200 (MA-Fungi 35121).



Figs. 2-4. *Cribraria tenella* (MA-Fungi 35131). 2. Peridial nodes and spores. 3-4. Spores. Figs. 5-7. *Diachea bulbilosa* (MA-Fungi 35121). Spores. Figs. 8-9. *Diachea radiata* (MA-Fungi 35108). Spores.

The spores as viewed by SEM have been described by RAMMELOO (1983) as "ornées de gros baculums, parfois plus ou moins en pointe au sommet, à surface finement granulée surtout vers le sommet". In our specimens, the bacula are somewhat spiny and towards the apex of the spines show divaricate protuberances (Figs. 5-7), similar to those described and illustrated by Rammeloo for the spores of *Comatricha pulchella* (C. Bab.) Rostaf.

***Diachea leucopodia* (Bull.) Rostaf.**

On dead branch and living leaves, TLXM sub RP 2177b, TLXM sub RP 2177c.

***Diachea radiata* G. Lister & Petch**

On dead leaves, TLXM sub RP 2184 (MA-Fungi 35108), TLXM sub RP 2186 (MA-Fungi 35109), TLXM sub RP 2217 (MA-Fungi 38481).

This species is clearly distinguished from *D. leucopodia* (Bull.) Rostaf. by the globose sporotheca. The spores by SEM, according to the terminology of RAMMELOO (1974), are the pilate type, the pilae are irregularly distributed and some of them could appear to be grouped or fused (Figs. 8-9).

In Mexico, it was previously reported from a temperate area of Veracruz (LÓPEZ et al., 1981). This is the first record from tropical vegetation in Mexico. In the Neotropics, it was previously known only from Panama and Chile (FARR, 1976).

***Diachea silvaepluvialis* M. L. Farr**

On dead leaves, TLXM sub RP 2198 (MA-Fungi 35118).

By SEM, the spores possess scanty and dispersed bacula with divaricate protuberances at the apex (Figs. 10-11), similar to those of *D. bulbilosa* (Berk. & Broome) Lister, but more pronounced. The stalks are filled with crystals (Fig. 12).

This is a tropical species described originally from Dominica (FARR, 1969). In continental America, it is also known from Florida (FARR, 1976). This is the first record for Mexico.

***Diderma spumarioides* (Fr.) Fr.**

On phylloclades of *Opuntia* sp. and dead branches, TLXM sub RP 2158 (MA-Fungi 38476), TLXM sub RP 2159 (MA-Fungi 38477), TLXM sub RP 2164 (MA-Fungi 35091).

In these specimens, the deposits of carbonate of the hypothallus are scanty.

***Diderma effusum* (Schwein.) Morgan**

On a dead branch and dead or living leaves, TLXM sub RP 2207, TLXM sub RP 2218 (MA-Fungi 38482), TLXM sub RP 2219.

***Fuligo megaspora* Sturgis**

On living leaves, TLXM sub RP 2201 (MA-Fungi 35122).

The large spores (13-16 μm diam) with tuberculate or strongly spinose ornamentation, more evident by SEM (Figs. 13-15), are the distinctive feature of this species. By SEM, the surface of the spore is regularly and minutely scrobiculate between the spines or serrated edges. The episporic reticulum illustrated by KELLER & SCHOKNECHT (1989) is not evident in our specimen.

The distribution of this species in Mexico indicates that it is frequent in ecosystems with dry weather conditions, such as juniper forests (HERNÁNDEZ-CUEVAS, 1993), *Pinus cembroides*-*Nolina* woodlands and tropical seasonal forests (personal

observations). This fact is also suggested by the annotations of Ellsworth Bethel, as cited by KELLER & SCHOKNECHT (1989), for a specimen from New Mexico collected at the beginning of this century, who noted that "These white aethalioid myxos are common on the hot desert sands and occasionally occur on the trunks of *Juniperus monosperma*, the only vegetation present as the drifting sands cover and destroy all other vegetation". In the Americas, the species is known from Costa Rica, Guatemala, Brazil and the southern United States (FARR, 1976), where it is particularly abundant in the Everglades (KELLER & SCHOKNECHT, 1989).

***Physarum cinereum* (Batsch) Pers.**

On dead branch, TLXM sub RP 2176.

***Physarum compresum* Alb. & Schwein.**

On dead wood, TLXM sub RP 2202 (MA-Fungi 35123).

***Physarum didermoides* (Pers.) Rostaf.**

On dead wood, TLXM sub RP 2188 (MA-Fungi 35110).

***Physarum javanicum* Racib.**

On bark, TLXM sub RP 2190 (MA-Fungi 35111).

Described from the island of Java and frequent in tropical areas. In the Neotropics, it is known from Costa Rica, Cuba, Jamaica, Puerto Rico, Colombia, Venezuela, Trinidad and Brasil (FARR, 1976). Not previously reported from Mexico.

***Physarum leucopus* Link.**

On branch and dead or living leaves, TLXM sub RP 2169 (MA-Fungi 35095), TLXM sub RP 2170, TLXM sub RP 2171, TLXM sub RP 2172 (MA-Fungi 35096).

***Physarum melleum* (Berk. & Broome) Massee**

On dead leaves, branch and bark, TLXM sub RP 2216, TLXM sub RP 2187

***Physarum nicaraguense* T. Macbr.**

On dead wood, TLXM sub RP 2196 (MA-Fungi 35115).

The spores are subglobose or slightly angular by mutual pressure (Fig. 16) and densely warted. By SEM, according to the terminology of RAMMELOO (1974), they are the baculate type (Fig. 17).

This is a species linked with tropical areas (MARTIN & ALEXOPOULOS, 1969). In Mexico, it was previously recorded from Chiapas (BRAUN & KELLER, 1976) and Veracruz (VILLARREAL, 1985). EMOTO (1933) also reported it from Mexico but without specifying the locality.

***Physarum nutans* Pers.**

On dead wood, bark, TLXM sub RP 2159b (MA-Fungi 38478), TLXM sub RP 2174 (MA-Fungi 35098), TLXM sub RP 2174b, TLXM sub RP 2175 (MA-Fungi 35099).

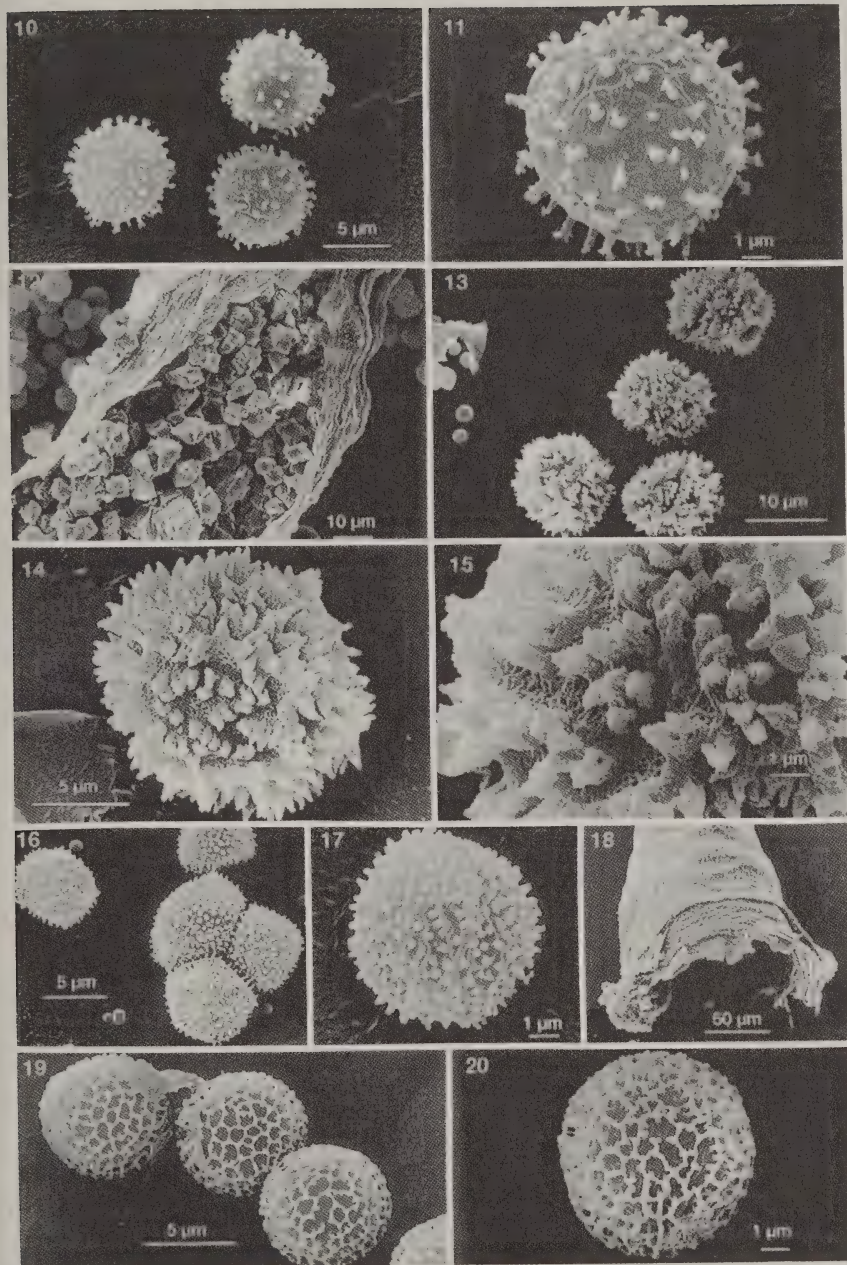
***Physarum serpula* Morgan**

On dead branch and bark of *Bursera* sp., TLXM sub RP 2178, TLXM sub RP 2178a, TLXM sub RP 2179.

***Physarum viride* var. *aurantium* (Pers.) Lister**

On dead wood, bark, TLXM sub RP 2208 (MA-Fungi 35128), TLXM sub RP 2209 (MA-Fungi 35129).

First record for México.



Figs. 10-12. *Diachea silvaepluvialis* (MA-Fungi 35118). 10-11. Spores. 12. Section of a stalk filled with crystals. Figs. 13-15. *Fuligo megaspora* (MA-Fungi 35122). Spores. Figs. 16-17. *Physarum nicaraguense* (MA-Fungi 35115). Spores. Figs. 18-20. *Stemonaria longa* (MA-Fungi 35081). 18. Base of the stalk. 19-20. Spores.

Order STEMONITALES

Comatricha pulchella (C. Bab. ex Berk.) Rostaf.

On living branch, TLXM sub RP 2151 (MA-Fungi 38475).

Comatricha tenerrima (M. A. Curtis) G. Lister

On dead wood, TLXM sub RP 2152a (MA-Fungi 35083), TLXM sub RP 2152b, TLXM sub RP 2157 (MA-Fungi 35087), TLXM sub RP 2185 (MA-Fungi 38479), TLXM sub RP 2214, TLXM sub RP 2222 (MA-Fungi 35135).

Lamproderma arcyrionema Rostaf.

On dead wood, TLXM sub RP 2150a (MA-Fungi 35082), TLXM sub RP 2150b, TLXM sub RP 2192 (MA-Fungi 38480).

Stemonaria longa (Peck) Nann.-Bremek., R. Sharma & Y. Yamam.

On bark and dead branch, TLXM sub RP 2149 (MA-Fungi 35081), TLXM sub RP 2220 (MA-Fungi 35134).

The long sporocarps (up to 50 mm in total height), the open capillitium, and the reticulate spores make this species easily recognizable. MARTIN & ALEXOPOULOS (1969) placed this species in the genus *Comatricha* on the basis of the lax, delicate capillitium, with slender tips pointing outwards, penicillately branched, and without a surface net. Contrary to the rest of species of this genus, the absence of netted fibres in its stalks is evident (Fig. 18). For this reason, we agree with NANNENGA-BREMEKAMP *et al.* (1984) and consider it as belonging to the genus *Stemonaria*.

By SEM, the ornamentation of the spores (Figs. 19-20) corresponds to the simple reticulate type with perforated muri as defined by RAMMELOO (1975).

Previously recorded in Mexico from the states of Chiapas (EMOTO, 1933) and Veracruz (WELDEN & GUZMÁN, 1978).

Stemonitis flavogenita E. Jahn

On dead wood, TLXM sub RP 2153b, TLXM sub RP.

Stemonitis herbatica Peck

On dead branch and leaves, TLXM sub RP 2156 (MA-Fungi 38483), TLXM sub RP 2203a (MA-Fungi 35124), TLXM sub RP 2203b.

Stemonitis nigrescens Rex

On dead wood, TLXM sub RP 2153a.

Stemonitis smithii T. Macbr.

On dead wood, TLXM sub RP 2153a (MA-Fungi 35084), TLXM sub RP 2153b (MA-Fungi 35085).

Stemonitis fusca Roth

On dead branches, TLXM sub RP 2153b.

Stemonitopsis aff. *gracilis* (G. Lister) Nann.-Bremek.

On dead wood, TLXM sub RP 2155a (MA-Fungi 38484).

Our specimen resembles *S. gracilis* on the basis of size and form of the sporocarps, the features of the capillitium, and the ornamentation of the spores. Nevertheless, the stipes are very long (1/2 vs. 1/5 of the total length) and the spores are larger (7.5-8 vs. 5-7 mm diam.) than those described by NANNENGA-BREMEKAMP

(1991). If the identification of the species is confirmed, it would be a new record for Mexico.

Stemonitopsis typhina (F.H. Wigg.) Nann.-Bremek.

On dead wood, bark, TLXM sub RP 2154 (MA-Fungi 35086), TLXM sub RP 2197a (MA-Fungi 35116), TLXM sub RP 2197b (MA-Fungi 35117).

This species was previously reported from Mexico as *Comatricha typhoides* (Bull.) Rostaf. (OGATA et al., 1994, 1996).

Our data from the Chamela Biological Station reflect the high diversity of myxomycetes in a tropical forest. In a few days of sampling, in a very reduced area, we found 41 taxa of myxomycetes (including five taxa not previously reported from the country) representing seventeen genera (Table 1). This collection represents 19.43% of the 211 species currently known in Mexico (MARTÍNEZ-MURILLO & LÓPEZ-OCHOTERENA, 1970; TRUJILLO, 1988; HERNÁNDEZ-CUEVAS et al., 1991; OGATA et al., 1994, 1996; RODRÍGUEZ-PALMA & ESTRADA-TORRES, 1996; HERNÁNDEZ-CUEVAS & ESTRADA-TORRES, 1997; LIZÁRRAGA et al., 1997). All six recognized orders of myxomycetes were present in the region studied. The best represented genus was *Physarum* (with 10 species), followed by *Stemonitis* (5 species), and *Cribraria* and *Diachea*, each with four species (Table 1).

Table 1. Orders and genera of myxomycetes collected in the vicinity of the Chamela Biological Station and their distribution by substrata.

Order	Genera (No. species)	Lignicolous Species	Foliicolous Species
Ceratiomyxales	Ceratiomyxa (1)	1	
Liceales	Cribraria (4)	4	
	Lycogala (1)	1	
Echinosteliales	Clastoderma (1)	1	
Trichiales	Arcyria (2)	2	
	Hemitrichia (2)	2	
	Perichaena (1)	1	
Physarales	Craterium (1)	1	1
	Diachea (4)	1	4
	Diderma (2)	2	1
	Fuligo (1)		1
	Physarum (10)	10	2
Stemonitales	Comatricha (2)	2	
	Lamproderma (1)	1	
	Stemonaria (1)	1	
	Stemonitis (5)	5	1
	Stemonitopsis (2)	2	

DISCUSSION

The myxomycetes are common inhabitants of forest ecosystems throughout the world (MARTIN & ALEXOPOULOS, 1969; STEPHENSON, 1989; STEPHENSON & STEMPEL, 1994), but the scarcity of fossil records, limited monographic or biosystematic studies, and patchy knowledge of their distribution make the interpretation of their biogeography and phylogenesis difficult. Concepts such as geographical barriers and isolation are difficult to apply to the group.

However, some species found in Chamela, such as *Diachea silvaepluvialis*, *Physarum nicaraguense* and *Ph. javanicum*, are predominantly tropical in their distribution; others such as *Cribraria tenella*, *Hemitrichia calyculata* and *Lycogala exiguum*, are considered cosmopolitan (MARTIN & ALEXOPOULOS, 1969), and are also especially common in the African tropics (HÄRKÖNEN & SAARIMÄKI, 1991; LADO & TEYSSIERE, 1998).

It is interesting that four of the 12 species of *Diachea* known in the world (MITCHELL, 1996) were found in Chamela, an area of only 1600 ha. Except for *D. leucopodia*, a cosmopolitan species, we confirm the tropical tendency in the distribution patterns of the rest (*D. bulbillosa*, *D. radiata* and *D. silvaepluvialis*), where these foliicolous species are apparently abundant. The presence of four species of *Cribraria*, a genus generally associated with the conifers of the boreal forests (MARTIN & ALEXOPOULOS, 1969), is also remarkable.

Almost all the species found in Chamela are lignicolous (31 species), and only a few (4 species) are foliicolous; 6 more are found on both leaves and wood (Table 1). Leaves are an important substratum for myxomycetes in tropical and boreal forests, but the low number of foliicolous species reported in Chamela may be due to the time of sampling, at the end of the rainy season, when the dead leaves were almost completely rotten.

Some general studies on the distribution patterns of myxomycetes seem to indicate that these organisms are less abundant in tropical forests than they are in temperate forests (ALEXOPOULOS, 1970; FARR, 1976; MAIMONII-RODELLA & GOTTSBERGER, 1980; ING, 1994). However, recent field work, such as the studies carried out by HÄRKÖNEN & SAARIMÄKI (1991) or LADO & TEYSSIERE (1998), in tropical Africa, or the data here from a reduced Neotropical area, seem to refute this assumption. Relatively few studies have been carried out in the tropics in comparison to those in temperate areas, and obviously less information is known about myxomycete communities from the tropics. In addition, some data indicate that some species occur exclusively in tropical areas or have a strong preference for the tropics (FARR, 1976; LAKHANPAL & MUKERJI, 1981).

As an explanation of the lesser abundance of myxomycetes in tropical places, BLACKWELL (1984) and WHEELER (1984) have suggested that tropical myxomycetes may spend most of their life cycles as plasmodia, and only occasionally form fruit bodies. In Chamela, at the end of the rainy season, we observed very few plasmodia on the ground and many fructifications. Seasonality of the rains could be the major cause of the difference in their reproductive phenology, which contrast with the minor seasonal variations normally observed in tropical rain forests. In this way, the

reproductive behavior of myxomycetes of Chamela is closer to that of temperate ecosystems. In conclusion, the proposal of BLACKWELL (1984) and WHEELER (1984) is not necessarily applicable to all tropical environments. The low level of abundance of tropical myxomycetes, as suggested by STEPHENSON & STEMPEN (1994) and supported by our data, is perhaps more illusory than real. In our opinion, questions relating to the abundance or absence of myxomycetes in tropical forests, could be resolved by visiting and collecting in the same areas across seasons.

Acknowledgments

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MYCOTAXON

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THE LICHEN GENUS *PARMELIELLA* (PANNARIACEAE) FROM THE ANDAMAN AND NICOBAR ISLANDS OF INDIA

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ABSTRACT

Three species and a variety of the lichen genus *Parmeliella* have been recorded from the Andaman and Nicobar Islands of India. *Parmeliella allochroa*, *P. endomilta* var. *achromatica* and *P. macrospora* have been described as new taxa. *P. brisbanensis* has been recorded for the first time from India.

INTRODUCTION

Parmeliella, a mainly subtropical-temperate genus, epiphytic or on rock, rarely on ground in humid and often shaded habitats known by 30-40 species (Jørgensen & Galloway, 1992) world wide is included in the family Pannariaceae. The genus has been studied in recent years in Europe (Jørgensen, 1978), New Zealand (Galloway, 1985) and in Australia (Jørgensen & Galloway, 1992). The only paper dealing with the species South East Asia is that of Vainio (1921) which is largely outdated.

The monograph of the European taxa of Pannariaceae (Jørgensen, 1978) was mainly devoted to a treatment of the species. The genera were not treated except for the nomenclature, because their circumscription was found unclear. In spite of considerable work and exhaustive studies Jørgensen (1978) deliberately passed no opinion on the generic and infrageneric taxonomy. He proposed informal grouping of unspecified rank and concluded that it seems at the moment desirable to retain the genera *Pannaria*, *Parmeliella* and *Psoroma* as distinct entities.

In the treatment of the Pannariaceae in the *Flora of Australia* (Jørgensen & Galloway, 1992) it has been stated that the Pannariaceae a fairly well circumscribed and characterised by the combination of its special apothecia, its chemistry and squamulose-foliose thallus with dark rhizohyphae on the lower surface, is a family of twelve genera. Nine genera have been delimited and characterised including *Parmeliella* Müll. Arg.

However, Henssen (1997) while discussing the systematic position of the new genus *Santessoniella* clearly states that, "since the ascus type is quite different in *Pannaria* s. str., there is reason to believe that *Parmeliella* and *Santessoniella* do not belong in Pannariaceae," in the present paper *Parmeliella* is referred to Pannariaceae, until the systematic position of the two genera will be clarified.

The Andaman and Nicobar Islands, from a botanical point of view have a special

position in the Indian subcontinent for their interesting flora. The vegetation is typically a tropical one. Being separated by a considerable stretch of sea from Indian mainland there are remarkable floristic differences from the mainland vegetation in its constituents and have large number of Malaysian elements due to proximity besides their own elements that is endemic taxa due to insular position.

The flora of Nicobar is still in its original form, unmixed and untouched by man owing to its isolated position. It may therefore be assumed that its flora may still contain a number of new and endemic species.

Parmeliella is not adequately known in India and in the present study of this genus from the Andaman and Nicobar Islands of India where they do not occur in abundance it is rather too early to draw any conclusions and discuss the importance of taxonomic characters and their variation in each species.

Generally, in *Parmeliella* there is little variation in anatomy and spore size among known species, and the genus has no chemical characters of any importance. With the limited knowledge of this genus, it is difficult at this stage to evaluate the significance of characters such as colour (yellow or brown or grey), width of the lobes, whether they are discrete or fused, production of isidia, and thickness of the thallus, etc. in taxonomy of species. Presently taxonomy is based very much on external characters such as the thallus morphology which varies considerably according to microhabitat and microclimate conditions. The validity of a species must not be based on a single character but it should be based on several carefully evaluated characters.

The species described here are characterised by fairly well developed thalli composed of flat to more convex thallus areoles in the central portions and distinctly delimited marginal lobes at the edges. The characters, however, vary between the species. The marginal lobes are best developed in *Parmeliella macrospora* and *P. brisbanensis*. The marginal lobes are more broad than linear as compared to the other species e.g. in *P. allochroa* and *P. endomilta* var. *achromatica* in which the marginal lobes usually become more flattened and fused or not so distinctly effigurate and narrow. It has been observed that the shape and structure of the marginal lobes, however, does not vary much within individual species.

Isidia occur in several species, and the presence or absence of these is often used to separate taxa at species level. Out of the four taxa described here three are isidiate.

The structure of the cortical layer is not variable within the species described here and characterised by paraplectenchymatous cortex.

Many specimens from Indonesia and the Philippines contain yellowish / reddish pigments and the slight difference in thallus colour may be due to the presence of different types of pigment e.g. *P. endomilta* Vainio has pigmented medulla (KOH+ violet) is tawny brown in colour. But, the field observations suggest that in the species without pigment it can be correlated with environmental conditions. For instance, in specimens of *P. allochroa* from Elphiston Bay (Andaman Islands) growing on trunks in rather exposed conditions the colour of the thallus is darker (grey). Specimens from exposed localities usually have darker thallus than those from shady places. Thalli which are partly becoming discoloured or darkened as it has been observed in *P. endomilta*

var. *achromatica* it is very difficult to say what causes such change. In all species the felted marginal prothallus is prominent well developed beyond the margins of the lobes and appear to be genetic.

Thalline margin is absent in the apothecia in all species of *Parmeliella* (Jørgensen, 1994) with only one notable exception *Parmeliella mariana* (Fr.) P.M. Jørg. & D.G. Galloway. The two species *P. allochroa* and *P. macrospora* which belong to *Parmeliella mariana* complex have secondary thalline margin. The colour of the apothecial disc varies from pale yellowish to dark brownish-red or even black in different apothecia on the same thallus. It seems that the colour of apothecia is of no taxonomic importance.

Pycnidia have been observed in all specimens.

GENUS: *PARMELIELLA* MÜLL. ARG.

The genus *Parmeliella* Müll. Arg. [*Mém. Soc. Phys. Genève* **16**: 376 (1862) Type: *P. triptophylla* (Ach.) Müll. Arg.], is characterised by: *Thallus* crustose squamulose to foliose, heteromerous, dorsiventral, loosely or closely adpressed, often with a prominent black or blue-black, rarely buff or pale, byssoid, marginal prothallus of projecting, felted silky rhizohyphae, pale-fawn to shades of leaden grey and greyish-brown, corticate above, non corticate below. *Lobes* variable, broad and rounded to laciniate, or morphophylline and more or less lobulate-squamulose, flat to convex, discrete to imbricate. Upper surface dark blue-green, plumbeous to fawnish, smooth or wrinkled-plicate, matt, glossy or more or less scabrid or pubescent, with or without isidia or phyllidia and soralia, maculae and pseudocyphellae absent. *Medulla* white. Photobiont blue-green (*Nostoc*) in clusters, not penetrating into base of hymenium. Lower surface tomentose or rhizinate. *Rhizines* felted, blue-black to whitish, often projecting beyond lobes margins as a byssoid prothallus. *Ascomata* apothecial, sessile to substipitate, rounded, biatorine or with secondary thalline margin; disc flat to concave, epruinose, red-brown to brown, rarely blackish; proper exciple distinct pale, thalline exciple rarely present, crenulate, obscuring proper exciple; hymenium hyaline, I+ persistently blue. *Asci* with a distinct apical amyloid ring. *Ascospores* 8 per ascus, $\pm$ uniseriate, simple, colourless, oblong to ellipsoid, smooth, occasionally apiculate at one or both ends; exosporium thin or absent. *Conidiomata* pycnidial present.

Awasthi (1988) recorded three species of *Parmeliella* from the Indian subcontinent namely *P. plumbea* (Lightf.) Vainio now in the genus *Degelia* is doubtfully present in India, and *P. triptophylla* (Ach.) Müll. Arg. from the Nilgiri hills and *P. pannosa* (Swartz) Müll. Arg. from the Andaman Islands.

The present account is based on recent collections made by Dr. P.G. Patwardhan and his associates during the period 1985-1988 in the Andaman and Nicobar Islands of India and have been deposited in the Ajrekar Mycological Herbarium (AMH) at ARI, Pune, India. In the Andaman and Nicobar Islands species of *Parmeliella* prefer habitats with moderate shade or in open, warm, moist and high humidity especially in coastal sites on bark of the trees. Six taxa of *Parmeliella* are recorded from the Andaman and Nicobar Islands of India.

ECOLOGY AND DISTRIBUTION

The Andaman and Nicobar Islands lie in a chain in the Bay of Bengal on the southward trend line of the Himalayan range. The Andamans comprise 204 islands between 13° 41' and 10° 30' North latitudes and 92° 11' and 93° 7' East longitudes and are thought to contain India's main surviving primary forests-tropical evergreen rainforest dominated by *Dipterocarpus* and rich in *Pterocarpus* and *Mesua ferrea*. The tropical semi-evergreen and moist deciduous forests, with their commercially important teak and sal, are under severe pressure from logging and agriculture. The Nicobars lie between 6° 40' and 9° 30' North latitudes and 92° 30' and 94° 10' East longitudes, are composed of 22 volcanic islands south of the Andamans, and the major upper canopy genera are *Hopea*, *Astonia*, *Calophyllum*, and *Terminalia*. The low float islands of the northern Nicobars support scrub forest. Coastal areas in both island groups are bordered with mangrove forests and littoral vegetation.

The pyrenocarpous, graphidaceous lichens and thelotremes, which are corticolous in nature, predominate the lichen flora of these islands. The foliose and the fruticose lichens are of rare occurrence in the Andaman and Nicobar Islands. Like *Coccocarpia* and *Leptogium*, *Parmeliella* is one of the rare macrolichen genera which occur in these islands and is relatively frequent among mosses and on more or less exposed tree trunks on the road sides in the forests.

MATERIALS AND METHODS

The specimens were examined with a stereomicroscope and a light microscope. Sections of the thalli and apothecia were stained with Lugol's solution. All sections were examined with lactophenol as mounting medium. TLC was done by the standard method (Culberson & Kristinsson, 1970) using solvent systems benzene-dioxane-acetic acid (180:45:5, 230 ml) and hexane-ethylether-formic acid (130:80:20, 230 ml). All specimens were observed under UV light (365 nm).

KEY TO THE SPECIES

1a. Thallus without isidia.

Thallus 5–17 cm wide, pale brown, marginal squamules 7–9 mm long, 0.5–1.5 mm broad; prothallus blackish-brown, well developed, forming a distinct spongy layer at periphery; apothecia numerous, 0.2–1(-1.2) mm in diam.; ascospores 21–25 x 6–8.4 µm. *Parmeliella macrospora*

1b. Thallus with isidia 2

2a. Lobes usually more than 2 mm broad

Thallus foliose-squamulose, 6–15 cm wide, contiguous, elongate up to 7–9 mm long, rarely discrete, strongly adpressed, with round apices, 2–3 mm broad, bluish-black to brownish within; isidia all over the surface concolorous to slightly darker, terete, distinctly branched, coralloid; apothecia absent.....
..... *Parmeliella endomilta* var. *achromatica*

2b. Lobes usually narrow, often less than 2 mm broad 3

- 3a. Thallus pale-grey; marginal lobes elongate, fused to discrete, often rounded, 0.5–1 mm broad; isidia short, terete, simple to branched, forming crust; apothecia numerous, 0.5–3.0 mm in diam., with light brown to dark reddish-brown disc surrounded by crenulate, often isidiate secondary thalline margin; ascospores ellipsoid, 21–26 x 8–12 μm in size *Parmeliella allochroa*
- 3b. Thallus greyish-black to brownish; marginal lobes elongate to 5–7 mm, narrow, discrete, deeply incised, 0.5–0.7 mm broad; isidia numerous, crowded to form crust; apothecia absent *Parmeliella brisbanensis*

TAXONOMIC DESCRIPTIONS

Parmeliella allochroa sp. nov.

[Figs.: 1-7, 15,16]

Type: India, Nicobar Islands, Car Nicobar, Kimus, on Coconut palm, 29.12.1986, P.G. Patwardhan & P.K. Sethy, 86.787 (Holotype-AMH).

Thallus plus minusve orbicularis, ad 7–11 cm latus, adpressus, pallido brunneolus, vel griseosus, lobulis peripheris elongatis, confluentis aut discretis, usque ad 0.5–1 mm latis, isidiis, cylindricis, simplicibus aut ramosis, congestiis. Apothecia frequentia, numerosa ad 0.5–3 mm in diam., margino thallino crenulato, saepe isidiato; ascosporae 21–26 μm longae et 8–12 μm latae, apicibus rotundatis aut acutis, et raro apiculatis.

Thallus rosette forming, orbicular, 7–11 cm wide, closely adpressed, lobes often elongate, 0.5–1 mm broad, fused to discrete at margins or confluent from margin without visible division to centre, cracked, becoming areolate. Upper surface pale-brown to dark grey with reticulations made up of exposed medulla, isidiate. *Isidia* all over the thallus, often with squamulose lobules in between, sometimes compacted into an isidiate crust which completely obscures the squamules, concolorous, short, terete, simple to branched. *Prothallus* black, sponge like mat, well developed, 2–4 mm extending beyond squamules. *Thallus* 150–160 μm thick. Upper cortex 25–33 μm , composed of paraplectenchyma of thin walled, round to oblong cells 8.2 μm across. *Algal layer* 105 μm thick, with *Nostoc* clusters. *Medulla* up to 84 μm thick, made up of intricate hyphae forming a lax plectenchyma, gradually merging into the prothallus. *Apothecia* frequent, numerous, aggregated towards centre, 0.5–3 mm in diam., with a light brown to dark reddish-brown disc, sometimes turning black, plane or sometimes convex, rounded to irregular in shape, with a crenulate, often isidiate, upto 105 μm thick secondary thalline margin, concolorous with the thallus. *Proper margin* 21–29 μm thick, subparaplectenchymatous, consisting of oblong cells, 8–10 x 4–5 μm . *Subhymenial layers* pale, yellowish-brown to colourless, 42–46 μm thick, composed of rather intricately interwoven hyphae. *Hymenium* about 100 μm thick, uppermost part brown, the remainder colourless, I+ blue. *Paraphyses* simple, septate, only slightly clavate at the apices. *Asci* clavate to subcylindrical, 63–84 x 8.4–16.8 μm , with apical, amyloid broad ring, I+ persistently blue. *Ascospores* 8 per ascus, monostichous, distichous, colourless, ellipsoid, smooth with permanent exospore, ends rounded to acute, rarely apiculate, 21–26 x 8–12 μm . *Pycnidia* numerous, immersed to semi-emergent, wart like when emergent, minute, black.

Chemistry: Thallus K- , C- , KC- , P-, UV-; no lichen substances present.

Specimens Examined: **Andaman Islands:** Elphiston Bay, Long Island Range, Beach forest, *M.B. Nagarkar & P.G. Patwardhan*, 85.2245, 85.2246. **Nicobar Islands:** Car Nicobar, Kimus, *P.G. Patwardhan & P.K. Sethy*, 86.786, 86.787, 86.788, *P.K. Sethy & M.B. Nagarkar*, 86.776; Kamorta Island, Daring, *P.K. Sethy & P.G. Patwardhan*, 87.380, 87.381; Mallaca, *P.G. Patwardhan & M.B. Nagarkar*, 86.753, 86.754, 86.755, 86.757; Katchal, *P.G. Patwardhan & P.K. Sethy*, 86.319; Great Nicobar, Campbell bay to Laful bay, *P.G. Patwardhan & M.B. Nagarkar*, 87.91.

Remarks: *Parmeliella allochroa*, a member of the *P. mariana* group is characterised by the presence of its pale brownish to dark grey with elongate, fused to discrete marginal lobes to 0.5–1 mm broad, isidiate thallus, and by its numerous, large apothecia of 0.5–3 mm diam., with light brown to striking brown disc surrounded by often isidiate, crenulate secondary thalline margin and by its large ascospores of 21–26 x 8–12 μm .

Interestingly the specimens collected on coconut palm in the beach forest of the Nicobar Islands are invariably brownish and moderately isidiate where as in the specimens collected from the Elphiston Bay in the Middle Andaman on the tree trunk from beach forest, the colour of the thallus is dark grey and isidia are so abundant that they completely obscure the squamules.

The present species is mainly coastal, on trees commonly associated with the members of the Graphidaceae.

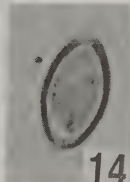
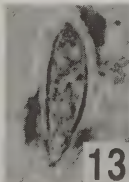
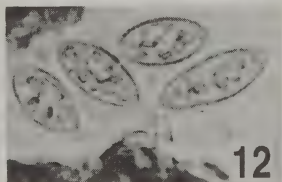
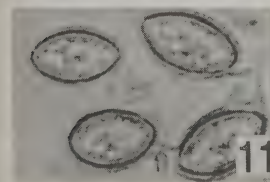
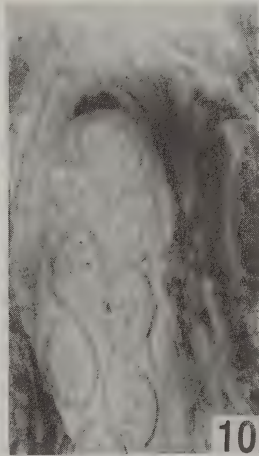
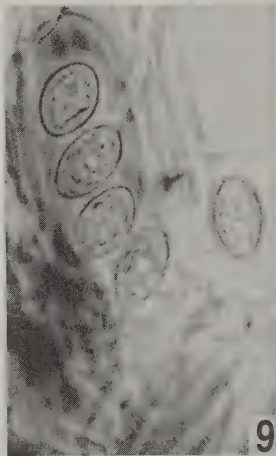
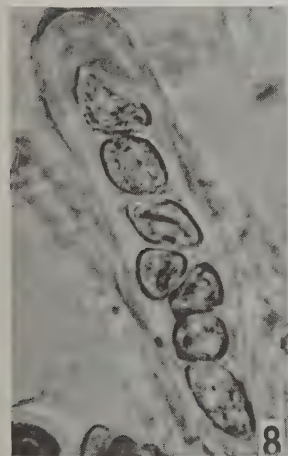
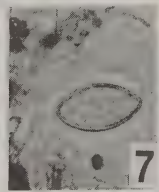
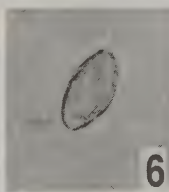
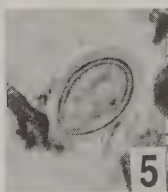
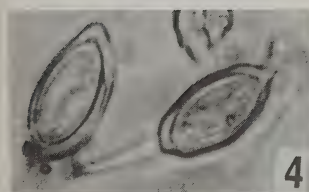
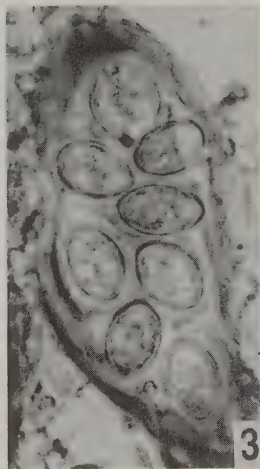
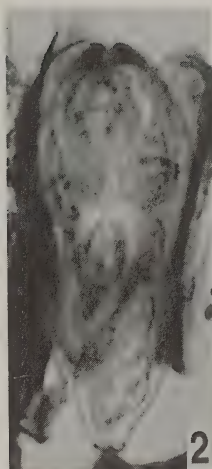
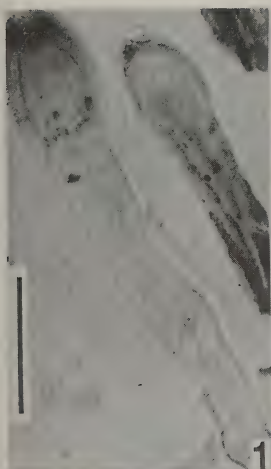
Parmeliella brisbanensis (C. Knight) P.M. Jørg. & D.J. Galloway [Fig.: 17]
Fl. Australia 54: 316, 1992.

= *Pannaria brisbanensis* C. Knight in J. Shirley
Proc. Roy. Soc. Queensland 6: 194, 1890.

Thallus foliose squamulose, orbicular to round, 2.5–8 cm wide, radiating, marginal lobes elongate, 5–7 mm long, deeply incised, discrete at margins, narrow, with apices rounded, 0.5–0.7 mm broad, appressed and dispersed on an extensive, continuous black prothallus. Upper surface greyish-black to brownish. *Isidia* numerous, all over the surface, often crowded with squamulose lobules in-between, sometimes compacted into an isidiate crust, concolorous to slightly dark, leaden grey to brownish, terete, sometimes branched. *Prothallus* black, well developed, extended 1–2 mm beyond the margins as a broad, spongy felt like layer. *Thallus* 147–168 μm thick. Upper cortex 13–16.8 μm , composed of paraplectenchyma of thin walled, round to oblong cells of 8–10 μm across. *Algal layer* 63–71 μm , with *Nostoc* clusters. *Medulla* 63–84 μm thick of intricate hyphae forming a lax plectenchyma, gradually merging into the blue-black prothallus. *Apothecia* absent.

Chemistry: Thallus K- , C- , KC-, P-, UV-; no lichen substances present.

Figs.: 1–14: 1–7. *Parmeliella allochroa* (86.787-Holotype-AMH) 1–3. asci; 4–7. ascospores. 8–14. *Parmeliella macrospora* (86.778-Holotype-AMH) 8–10. asci; 11–14. ascospores. Bar = 20 μm .



Specimens Examined: North Andaman: Sitapur, Diglipur Range, M.B. Nagarkar & P.G. Patwardhan, 86.121, 86.122, 86.123, 86.128. South Andaman: Baratang Island, Wrafter's Creek, P.G. Patwardhan, 85.511.

Remarks: The apothecia are absent in the specimens of this species at hand. However, on account of its general appearance it could be easily identified as *Parmeliella brisbanensis*. This species is easily distinguished from other species of this genus by its narrow, closely adnate, repeatedly branched, almost linear lobes with numerous, delicate, terete isidia, often crowded in centre with squamules compacted into crust.

The species is found in moist deciduous forests of the Andaman Islands. The associated species are *Dirinaria aegialita*, the members of Graphidaceae and pyrenolichens.

Parmeliella endomilta (Vainio) comb. nov.

[Figs.: 18, 19]

= *Pannaria endomilta* Vainio

Ann. Acad. Sci. Fenn. ser. A. 15:15, 1921. [Type: The Philippines, Mindanao, Distr. Davao, mons Apo (alt. 6000 p.s.m.), E.B. Copeland 1090 pr. p. Ster. In arbor-TUR (not seen)]

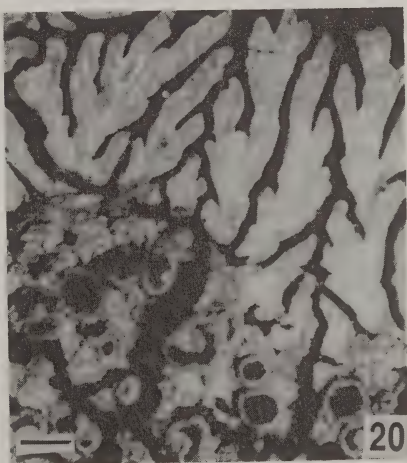
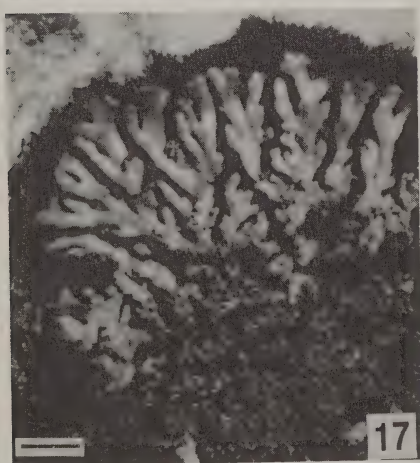
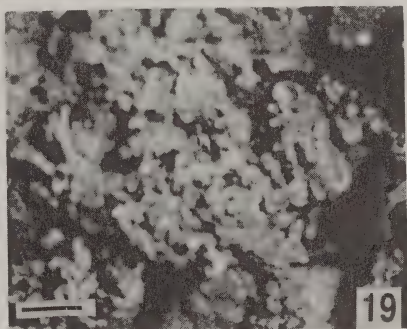
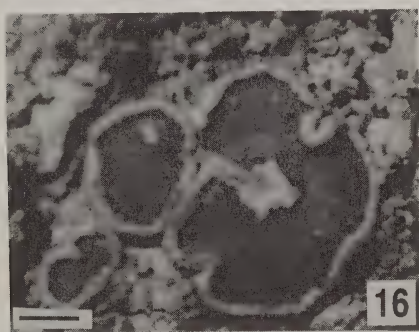
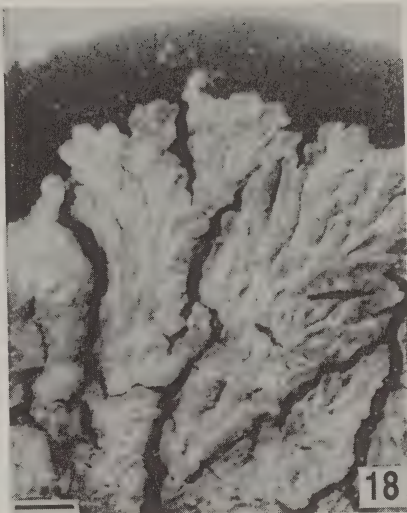
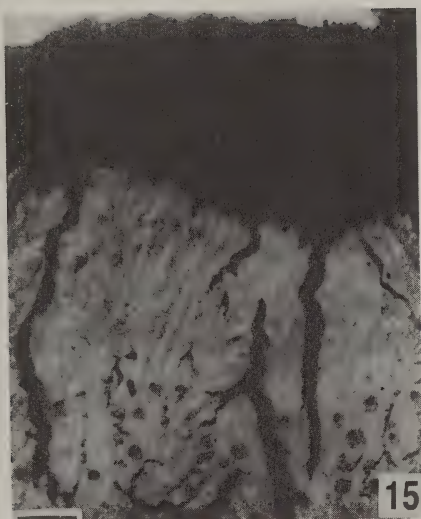
var. *achromatica* var. nov.

Type: India, North Andaman Island, Milangram, Diglipur Range, in evergreen forest, 8 km S.E. of Diglipur, 3.1.1986, M.B. Nagarkar & P.G. Patwardhan, 86.314 (Holotype-AMH).

Thallus foliaceous-squamulosus, atro-griseus vel plumbeus, intra brunneolus, ad 6–15 cm latus, contiguus raro discretus, valde adpressus, lobulis peripheris elongatis, ad 7–9 mm longis, 2–3 mm latis, apicibus rotundatis; isidiis cylindricis, simplicibus aut distincte ramosis coralloidis; prothallus nigricans, ad 1–1.5 mm extra thallum protensus. Apothecia destituta.

Thallus foliose squamulose, 6–15 cm wide, fused, contiguous, rarely discrete, strongly adpressed, marginal squamules often elongate, 7–9 mm long, rounded at apices, 2–3 mm broad. Upper surface bluish-black, brownish within, flat to concave. *Isidia* all over the surface with squamulose lobules in-between, thin, concolorous to slightly darker, terete, distinctly branched, coralloid. *Prothallus* blue-black, usually well developed and extended 1–1.5 mm beyond the lobes margin. *Thallus* 100–150 µm thick. Upper cortex 42–104 µm, composed of paraplectenchyma of round to oblong, thin walled cells of 6–12 µm across. *Algal layer* 42–63 µm, with *Nostoc* clusters. *Medulla* 21–29.4 µm thick made of intricate hyphae forming a lax plectenchyma, gradually merging into the blue-black prothallus. *Apothecia* absent.

Figs.: 15–20: 15–16. *Parmeliella allochroa* (86.787-Holotype-AMH) 15. distinct sponge-like prothallus; 16. thallus with terete, branched isidia and apothecia; 17. *Parmeliella brisbanensis* (86.123-AMH) radiating marginal, narrow lobes of the thallus on extensive prothallus; 18–19. *Parmeliella endomilta* var. *achromatica* (86.314-Holotype-AMH) 18. marginal lobes; 19. coralloid, branched isidia; 20. *Parmeliella macrospora* (86.778-Holotype-AMH). Bar = 1 mm



Chemistry: Thallus K-, C-, KC-, P-, UV-; no lichen substances present.

Specimens Examined: North Andaman, Milangram, Diglipur Range, M.B. Nagarkar & P.G. Patwardhan, 86.261, 86.296, 86.311, 86.312, 86.313, and 86.314. Nicobar Islands, Great Nicobar, Campbell Bay, P.K. Sethy & M.B. Nagarkar, 87.163.

Remarks: The specimens at hand have been regarded as the pigment deficient *Parmeliella endomilta* and have been treated just as the variety of this species. *P. endomilta* was described by Vainio (1921) as being an isidiate *Parmeliella leiostroma* but differs from our taxon in its pigmented, KOH+ medulla.

Parmeliella endomilta var. *achromatica* is distinguished and easily recognized by its rosette-forming thallus, orbicular to irregularly developed, large, 6–15 cm wide, dark blackish grey, brownish within, isidiate, closely adpressed on a thick, jet black prothallus projecting 1–2 mm beyond lobe apices.

This lichen has been found growing on tree trunk in evergreen forest of Milangram of North Andaman and it seems to be absent from other parts of the Andaman Islands. Associated species are *Laurera sphaerioides*, *Stirtonia macrocarpa*, *Graphina flexilis* etc. Only single specimen of this species has been collected from the Campbell Bay of Great Nicobar Islands in evergreen forest which has brown, 4–5 cm wide, closely adpressed, isidiate, confluent thallus without visible division of lobes with straight, blunt apices.

Parmeliella macrospora. sp. nov.

[Figs.: 8-14, 20]

Type: India, Nicobar Islands, Car Nicobar, Kimus, on coconut palm, 29.12.1986, P.K. Sethy & M.B. Nagarkar, 86.778 (Holotype-AMH).

Parmeliellae marianae similis, sed ascosporae magnae, 21–25 μ m longae et 6–8.4 μ m latae.

Thallus small-foliose squamulose, orbicular to irregularly spread, 5–17 cm wide, adpressed, marginal squamules discrete, often elongate to 7–9 mm long, with rounded ends, 0.5–1.5 mm broad, in centre confluent, without visible division between lobes, to minutely lobulate, flat, subconvex. Upper surface buff to yellowish-brown. *Isidia* absent. *Prothallus* blackish-brown, well developed, forming a distinct, narrow, spongy layer occasionally upto 4 mm beyond lobe apices. *Pycnidia* black, immersed in the thallus. *Thallus* 84–126 μ m thick. Upper cortex 16.8–29.4 μ m thick, composed of paraplectenchyma of thin walled, round to oblong cells of 8–10 μ m across. *Algal layer* 42–63 μ m thick with *Nostoc* clusters. *Medulla* 12.6–25 μ m thick of intricate hyphae forming a lax plectenchyma, gradually merging into the blackish-brown prothallus. *Apothecia* frequent, numerous, 0.2–1 (1.2) mm in diam., with a reddish-brown to blackish-brown, plane or sometimes slightly convex round to irregular disc with delicately crenulate, concolorous with the thallus, 105–118 μ m thick secondary thalline margin. *Proper margin* 25–42 μ m thick, subparaplectenchymatous, consisting of oblong cells. *Subhymenial layers* pale yellowish-brown, 42–63 μ m thick, of rather intricately interwoven hyphae. *Hymenium* about 84–124 μ m high, uppermost part brown, the remainder colourless, I+ blue. *Paraphyses* simple, septate, only slightly clavate at the apices. *Asci* clavate to subcylindrical, 71–96 x 16.8–37(–42) μ m with amyloid broad apical ring, I+ persistently deep blue. *Ascospores* 8 per ascus, monostichous, distichous

to irregularly arranged, colourless, ellipsoid with permanent exospore, ends acute to round, oblong, rarely apiculate, oil globules present, 21–25 x 6–8.4 μm in size.

Chemistry: Thallus K-, C-, KC-, P-, UV-; no lichen substance present.

Specimens Examined: **Andaman Islands**, Redskin Island, Wandoor, *P.K. Sethy & P.G. Patwardhan*, 85.2020. **Nicobar Islands**, Car Nicobar, Kimus, *P.K. Sethy & M.B. Nagarkar*, 86.777, 86.778, 86.781; Daring, Kamorta Island, *P.K. Sethy & P.G. Patwardhan*, 87.379.

Remarks: *Parmeliella macrospora* is characterised by very large, ca. 5–17 cm wide, buff coloured, foliose-squamulose thallus with marginal lobes often elongate to 7–9 mm; numerous apothecia (0.2–1.2 mm in diam.) with reddish-brown to blackish brown, epruinose, plane disc, and larger ascospores of 21–25 x 6–8.4 μm , with unusually thick exospore.

This characteristic species appears to be a member of the *Parmeliella mariana* group because of the presence of secondary thalline margin which is only known in this group and resembles the wide spread tropical species *Parmeliella mariana* (Fr.) P.M. Jørg. & D.J. Galloway from which it differs especially in having much larger ascospores. *P. mariana* has ascospores of 12–16 x 8–10 μm .

As it was suggested by P.M. Jørgensen we have studied the type of *Placolecnora liukuensis* Yasuda ex Räsänen which has proven to belong to *Parmeliella*. Unfortunately we could not get the type description of this lichen and found the type collection [Japan, Liukiu-Inseln. leg. Yasuda, no. 400, Ex Herb. Räsänen annotated and determined as "in *Parmeliella mariana* group" by P.M. Jørgensen (1998)-H(!)] rather poor and fragmentary. Not having seen the protologue we are not sure about the morphology of the thallus. The morphology and size of the apothecia are in agreement with our species but the ascospores are smaller (14–20 x 8–10 μm) as annotated on the specimens and also confirmed by us. We are not completely convinced that *Parmeliella macrospora* is identical to the *P. liukuensis*. Therefore, the specimens from our collection are provisionally assigned to the new species until the protologue and fresh material is available and can be studied.

A comparable species *Parmeliella allochroa*, described in the present paper, which has apothecia and has similar but slightly broader ascospores, differs from *Parmeliella macrospora* in having more robust leathery, densely isidiate thallus and much larger (about 3 times) apothecia of 0.5–3 mm in diam.

Further, *Parmeliella allochroa* and *P. macrospora* have been found growing side by side under the same environmental conditions and on the same substrate (coconut palm) in Nicobar Islands (Kimus and Kamorta in Car Nicobar Island). Thus the two species appear to be genetically distinct.

***Parmeliella pannosa* (Swartz) Müll. Arg.**

Flora Jena 64: 86, 1881.

= *Lichen pannosus* Swartz

Nov. Gen. Sp. Pl :146, 1788.

Remarks: Jatta (1905) reported a new variety *Parmeliella pannosa* var. *delicata* Jatta based on the material collected by E. H. Man from the Port Blair of the Andaman Islands (Type in NAP) and described as, "Laciniae graciliores, sericeo-plumbeae". Awasthi (1965) without having seen the specimen recorded this taxon in his Catalogue of the Lichens from India Nepal, Pakistan, and Ceylon and later (Awasthi, 1988) as *P. pannosa* in his key to the Macrolichens of India and Nepal. However, we have neither seen any specimen from Andaman Islands under this name, nor have we any specimen in our collection from the Andaman Islands to match this.

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STUDIES IN NEOTROPICAL POLYPORES 3* NEW AND INTERESTING BASIDIOMYCETES (PORIALES) FROM COSTA RICA

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Abstract: *Ceriporia microspora* I. Lindblad & Ryvarden, *Daedalea hydnoides* I. Lindblad & Ryvarden, *Diplomitoporus costaricensis* I. Lindblad & Ryvarden, *Hapalopilus tropicus* I. Lindblad & Ryvarden, *Inonotus xanthoporus* Ryvarden, *Junghuhnia minuta* I. Lindblad & Ryvarden, *Junghuhnia neotropica* I. Lindblad & Ryvarden, *Rigidoporus mutabilis* I. Lindblad & Ryvarden, *Trametes cystidiata* I. Lindblad & Ryvarden and *Wrightoporia efibulata* I. Lindblad & Ryvarden are described as new. The following new combinations are proposed: *Antrodiella duracina* (Pat.) I. Lindblad & Ryvarden, *Piloporia albomarginata* (Lév.) Ryvarden and *Wrightoporia braceii* (Murrill) I. Lindblad & Ryvarden. The genus *Piloporia* Niemelä is reported as new for America. Fertile specimens of *Hymenochaete unguolata* Burt are described for the first time.

Key words: Polyporaceae, *Hymenochaete*, *Piloporia*, Costa Rica.

Introduction

The polypores of Costa Rica are fairly well known due to investigations by Carranza and Saenz (1984), Carranza-Morse (1991, 1992, 1993) and Carranza and Ryvarden (1999). Nevertheless, during a study by one of us (I.L.) in Guanacaste Conservation Area, several unknown polypores were collected. These have been checked against unpublished keys to all known polypores from tropical America. The keys are based on a year long search in the literature for names and synonyms published from the neotropics besides extensive collecting in

* For previous papers in this series, see under References.

the area by one of us (L.R.). In total 440 species have been recorded so far in 71 genera. The new species have also been compared with African (Ryvarden & Johansen 1980), North American (Gilbertson & Ryvarden 1986-87) and European polypores (Ryvarden & Gilbertson 1993-94) and a forthcoming polypore flora of North East Asia (Nunez & Ryvarden in press), besides Corner's last studies (1983, 1984, 1987, 1989, 1995).

In addition, we also had the opportunity to examine a large collection of unnamed polypores accumulated over years in the INBio (Instituto Nacional de Biodiversidad) herbarium in Heredia in Costa Rica. The results of this examination are also included in the following report. Fertile basidiocarps of *Hymenochaete unguolata* Burt are reported for the first time and its microscopic characters are described.

Materials and methods

Microscopic examination of basidiocarps was made from freehand sections mounted in 5 % KOH aqueous phloxine, and in Melzer's reagent. All colour notations were made in accordance with Rayner (1970).

Descriptions

ANTRODIELLA DURACINA (Pat.) I.Lindblad & Ryvarden **comb. nov.** Basionym: *Leptoporus duracinus* Pat., Bull. Soc. Mycol. Fr. 18:174, 1902.

Basidiocarps pileate, annual, sessile to dimidiate and fan-shaped or semicircular, up to 8 cm long, 6 cm wide, 5 mm thick, tough when fresh, hard and brittle when dry, no special taste. Upper surface glabrous, ochraceous or very pale yellowish brown, usually zonate and often with some irregular basal outgrowths and narrow sulcate zones, in dry condition matted, but papery pelliculose on the surface. Margin thin and sharp and usually deflexed in dried specimens. Pore surface ochraceous to straw-coloured, pores 6-7 per mm, tubes dense and concolorous with pore surface in old specimens as if soaked by resinous substances, up to 2 mm deep. Context white to pale cream, distinctly paler than tubes, faintly duplex, up to 3 mm thick at the base.

Hyphal system dimitic, skeletal hyphae rare in the context, much more common in the trama, thick-walled with a distinct lumen, hyaline, 4-6 µm wide, generative hyphae dominating in the context, hyaline, 2-5 µm wide, similar in the trama.

Cystidia and other hymenial elements absent.

Basidia clavate, 8-12 x 4-5 μm .

Basidiospores allantoid to cylindrical, hyaline, negative in Melzer's reagent, 4-4.5 x 1-1.3 μm .

Substrate. On dead hardwoods, the type was found on *Cercopia peltata* in Guadeloupe.

Distribution. American species, recorded from Central America and the Caribbean islands (Puerto Rico, Guadeloupe, Colombia, Venezuela, Panama, Costa Rica).

Remarks. Previously this species was tentatively treated as a synonym of *A. versicutis* (Berk. & M. A. Curtis) Gilb. & Ryvarden (see Gilbertson & Ryvarden 1986:158) However, a recent study by Dai and Niemelä (1997) inspired us to look into the problem again based on numerous recent collections from tropical America. We were able to confirm the careful observations of Dai and Niemelä and conclude that the species are different although closely related.

A. duracina is separated from *A. versicutis* by larger pores, a paler pileus, a dominance of generative hyphae in the context, and contextual skeletal hyphae with a wide lumen. In *A. versicutis* the pileus is much darker, i.e. dark brown to pale chestnut with age and the pores are smaller (8-10 per mm). Further, the skeletal hyphae of *A. versicutis* are also almost solid and dominating in the context in contrast to the hyphal construction of *A. duracina* as outlined above.

Specimens examined. Costa Rica, Guanacaste prov., Guanacaste Nat. Park, Cacao, 1000 m a.s.l., on dead deciduous tree, 1997, I.Lindblad: 2436 C, 2485, 2553 A, 3034, 3042, 3045 B, 3053 B, 3055, 3081 B, 3636, 3669.

CERIPORIA MICROSPORA I.Lindblad & Ryvarden **nova sp.** Fig. 1
Fructificatio resupinata, pori albidis, rotundi ad angulatos, 6-8 per mm, tubi et contextibus albidis, systema hyphale monomiticum, hyphae generatoriae hyalinae, efibulatae, basidiosporae ellipsoideae, 3-3.5 x 1.5-2 μm .

Holotype: Costa Rica, Guanacaste prov., Santa Rosa Nat. Park, 7. November 1997, on dead deciduous tree, I.Lindblad 3709, in O. Isotype in Herb. INBio, Heredia, Costa Rica.

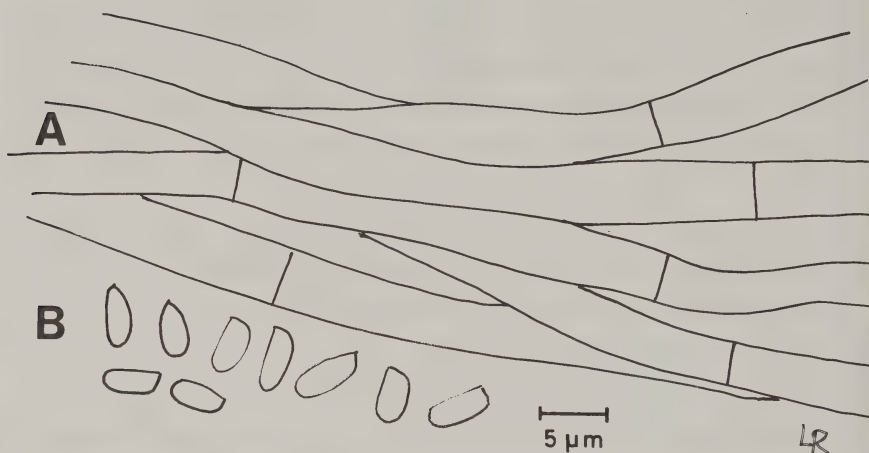
Etymology: Microspora = referring to the small basidiospores.

Basidiocarps annual to perennial, resupinate, brittle when dry, 1-2 mm thick. Margin narrow and sterile, diffuse, white. Pore surface white to buff, pores thin-walled, round to angular, slightly irregular, 6-8 per mm, tube layer concolorous, up to 2 mm deep. Subiculum very thin, cottony, white.

Hyphal system monomitic, generative hyphae hyaline, thin- to slightly thick-walled, simple-septate, with sparse branching, negative in Melzer's reagent, 3.5-6 μm in diam.

Cystidia and other sterile hymenial elements absent.

Basidia clavate, 4-sterigmate, 9-12 x 3.5-4.5 μm , simple-septate at the base.



Ceriporia microspora A) hyphae from the subiculum, B) basidiospores, from the holotype.

Basidiospores ellipsoid, hyaline, smooth, negative in Melzer's reagent, 3-3.5 x 1.5-2 μm .

Type of rot. White rot.

Substrate. On dead hardwoods. Recorded from *Quercus oleoides* (Fagaceae) and *Manilkara chicle* (Sapotaceae).

Habitat. Collected in seasonally dry tropical forest.

Distribution. Known only from the type locality.

Remarks. The species is separated from others in the genera by the small pores and minute spores.

Additional specimens examined. From the type locality, Costa Rica, Guanacaste prov., Santa Rosa Nat. Park, Santa Rosa, 300 m, 1997, on dead deciduous tree, I.Lindblad: 2140, 2141 B, 3292, 3708.

DAEDALEA HYDNOIDES I.Lindblad & Ryvarden **nova sp.** Fig. 2

Fructificatio sessilis, pileus brunneus, hymenophorum hydnoides, brunneum, systema hyphale trimiticum, hyphae generatoriae hyalinae, fibulatae, hyphae skeletales et ligniantes praesentia, cum cystidiis, basidiosporae ellipsoideae $6-7 \times 2-2.5 \mu\text{m}$.

Holotype: Costa Rica, Guanacaste prov., Pitilla, 700 m.a.s.l., 27 May 1997, on dead deciduous tree, I.Lindblad 2958, in O. Isotype in INB..

Etymology: Hydnoides = hydroid, referring to the conspicuous hymenophore.

Basidiocarps annual to perennial, pileate, broadly, narrowly attached to almost pendant, single or imbricate, semicircular and almost triquetrous in section, up to 4 cm broad, 3 cm wide and 1 cm thick near the base, consistency rubbery when fresh, coriaceous to hard when dry. Pileus surface rusty brown to dark brown, finely adpressed velutinate, slightly concentrically zoned, with age becoming glabrous. Margin acute, even or lobed. Lower surface whitish to cork coloured, hydroid with round to slightly flattened teeth, up to 7 mm long, 1-2 teeth per mm. Context cork coloured up to 3 mm thick at the base and with a very thin brown zone towards the upper surface of the pileus, but no cuticle present.

Hyphal system trimitic, generative hyphae hyaline, clamped and thin-to thick-walled, strongly branched in the subhymenium, $2-3 \mu\text{m}$ wide, skeletal hyphae thick-walled to solid, hyaline to pale brown, $3-8 \mu\text{m}$ in diameter, binding hyphae tortuous, hyaline, up to $3 \mu\text{m}$ wide, the upper brown adpressed tomentum of brown skeletal hyphae, $3-5 \mu\text{m}$ wide with a rounded apex.

Cystidia present as skeletocystidia bending into the hymenium, pointed, smooth and hyaline, up to $8 \mu\text{m}$ wide apically and of indeterminate length.

Basidia clavate, $12-15 \times 4-5 \mu\text{m}$ with 4 sterigmata.

Basidiospores cylindrical $6-7 \times 2-2.5 \mu\text{m}$, hyaline and non-amyloid, only observed on the pileus among the upper skeletal hyphae.

Type of rot. Apparently a brown rot.

Substrate. On dead hardwoods. Only collected on trees with soft, decayed surface and extremely hard core wood.

Habitat. Collected in tropical moist forest.

Distribution. Known only from the type locality.

Remarks. The rusty brown adpressed velutinate to glabrous upper surface and the densely hydroid hymenophore make this a very distinct species. From above the basidiocarps look exactly like those of *Gloeophyllum striatum* (Fr.) Murrill which however has a poroid

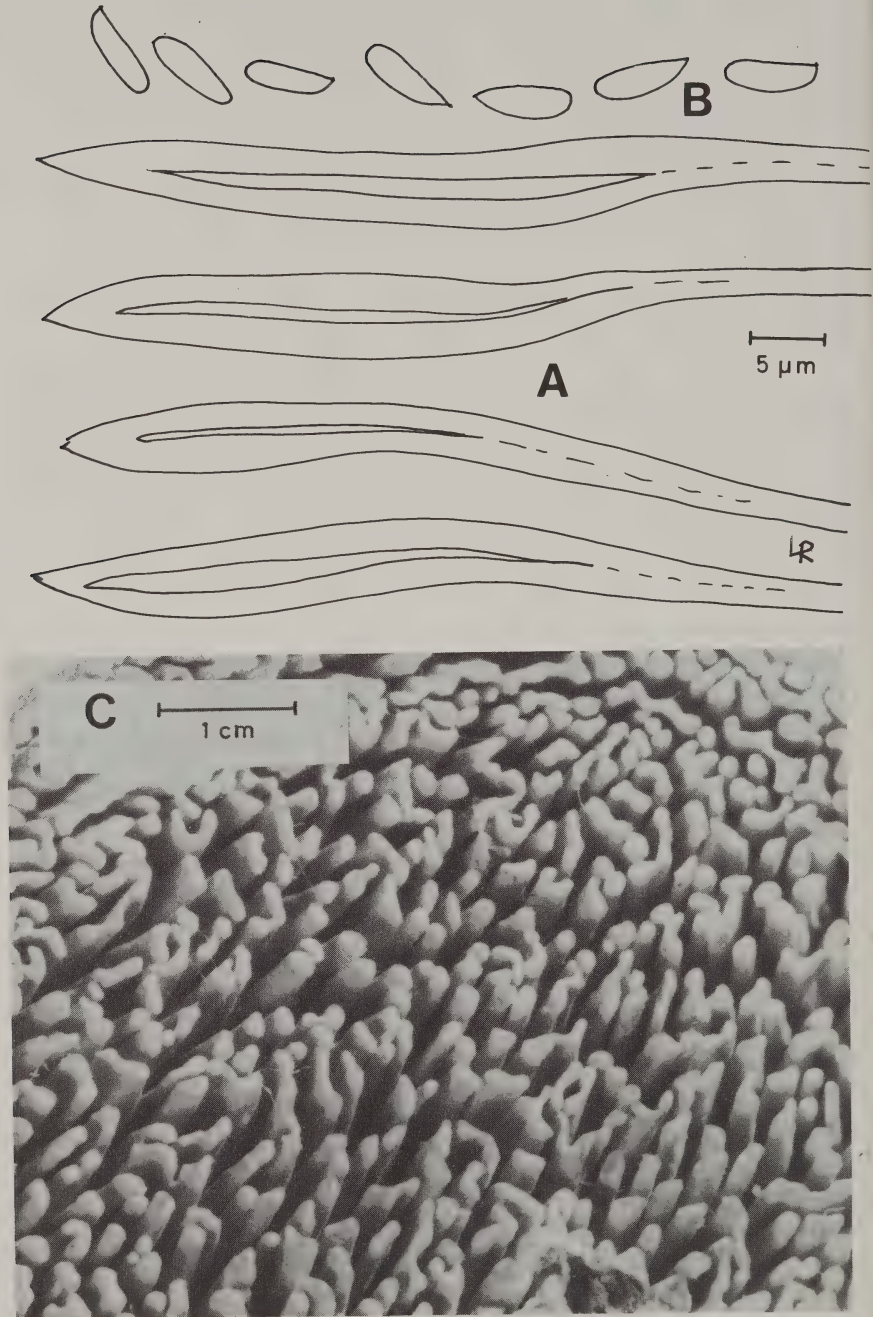


Fig 2. *Daedalea hydroides* A) cystidia, B) basidiospores, C) hymenophore. From the holotype.

hymenophore. The reason for not placing the genus in *Gloeophyllum* is mainly that all species in the genus have a dark brown context and no hydroid species has been described so far in the genus. On the other hand, species with a hydroid hymenophore are known in *Daedalea*, for example *D. stereoides* Fr. (for a description see Ryvarden & Johansen 1980:403 and Rajchenberg 1986), which however has a light coloured context and is pinkish to isabelline throughout the basidiocarp, thus distinctly different from the species described here.

Additional specimens examined. From the type locality, Costa Rica, Guanacaste prov., Cacao, 1000 m, on dead deciduous tree, 1997, I.Lindblad: 2381b, 2525, 2819, 3608, 3609, 3628, 3679.

DIPLOMITOPORUS COSTARICENSIS I.Lindblad & Ryvarden
nova sp.

Fructificatio resupinata resupinata, pori albidis vel cremicoloribus, rotundis, 6-8 per mm, tubi et contextibus albidis, systema hyphale dimiticum, hyphae generatoriae hyalinae, fibulatae, hyphae skeletales hyalinae, basidiosporae ellipsoideae, 4-4.5 x 2 μ m.

Holotype: Costa Rica, Guanacaste prov., Santa Rosa Nat. Park, 29 October 1996, on dead deciduous tree, I.Lindblad 2355, in O. Isotype in Herb. INBio, Heredia, Costa Rica.

Etymology: Costaricensis = from Costa Rica.

Basidiocarps perennial, resupinate, up to 3 mm thick, brittle to tough when dry. Margin narrow, white to cream. Pore surface white to cream, pores entire, round, regular, 6-8 per mm, tube layer concolorous with pores, zonate, each layer up to 1 mm thick, separated by thin layer of subiculum, subiculum 0.05 mm thick.

Hyphal system dimitic, generative hyphae hyaline, with clamps, ca 2 μ m wide, skeletal hyphae predominant, solid to thick-walled, hyaline, negative in Melzer's reagent, 1.5-3 μ m in diam, unbranched.

Cystidia and other sterile hymenial elements absent.

Basidia not seen.

Basidiospores ellipsoid, hyaline, smooth, negative in Melzer's reagent, 4-4.5 x 2 μ m.

Type of rot. White rot.

Substrate. On dead hardwoods. Recorded from *Hymenaea courbaril* (Leguminosae) and *Tabebuia rosea* (Bignoniaceae)

Habitat. Collected in seasonally dry tropical forest.

Distribution. Known only from the type locality.

Remarks. The species is recognized by its small spores and pores.

Diplomitoporus overholtsii (Pil.) Gilb. & Ryvarden which is also

known from the Central American area, has larger basidiospores, 5.5-7 x 3.5-5 μm . *Diplomitoporus dilutabilis* Loguercio-Leite & Wright was recently described from Brazil (Loguercio-Leite & J. Wright 1998) with a trimitic hyphal system and allantoid basidiospores, thus different from the new species described here. Besides these species, no other species of the genus has been reported from the Neotropics although a small number of tentatively new species in the genus are under examination by one of us (L.R.).

Additional specimens examined. From the type locality, 1997, I.Lindblad: 2466B, 3142A.

HAPALOPILUS TROPICUS I.Lindblad & Ryvarden **nova sp.**

Fructificatio resupinata resupinata, pori aurantiacis, rotundis, 6-8 per mm, tubi et contextibus aurantiacis, systema hyphale monomiticum, hyphae generatoriae hyalinae, fibulatae, basidiosporae subglobose vel subellipsoideae, 2-3 x 2.5-4 μm .

Holotype: Costa Rica, Guanacaste prov., Pitilla, 700 m.a.s.l., 27 May 1997, on dead deciduous tree, I.Lindblad 2958, in O. Isotype in Herb. INBio, Heredia, Costa Rica.

Etymology: tropicus = from the tropics, refers to its distribution.

Basidiocarps annual, resupinate, up to 4 mm thick, soft to tough when fresh, hard and resinous when dry. Margin up to 1.5 mm wide, sterile, orange when fresh, brick coloured when dry. Pore surface orange when fresh, darkening to red when touched, drying darker from brick to dark- or brown vinaceous, no reaction with KOH, pores entire, round, thin-walled, regular, 6-8 per mm; tube layer up to 2 mm thick, concolorous with pores when fresh, brown vinaceous to black when dry, azonate. Subiculum moderately thick, orange to brick coloured.

Hyphal system monomitic, generative hyphae hyaline to brown, with clamps, thin-walled, negative in Melzer's reagent, 2-3 μm wide. The structure is filled with resinous material that appears as bubbles in Melzer's reagent.

Cystidia and other sterile hymenial elements lacking.

Basidia clavate, 4-sterigmate, 9-12 x 4-5 μm , clamped at the base.

Basidiospores subglobose to broadly ellipsoid, hyaline, smooth, thin-walled, many with oil drops, negative in Melzer's reagent, 2-3 x 2.5-4 μm .

Type of rot. White rot.

Substrate. On dead hardwoods.

Habitat. Collected in tropical wet forest.

Distribution. Known only from the type locality.

Remarks. In the field this new species is similar to *Ceriporia spissa* (Schw.:Fr.) Rajchenb. in showing a colour-change from orange when fresh to vinaceous when dry. However, *C. spissa* has simple septate hyphae and allantoid basidiospores, and thus is grossly different microscopically from the new species described above.

The closest relative to the new species seems to be *Hapalopilus mutans* (Peck) Gilb. & Ryvarden which however has larger basidiospores, 4.5-6 x 3-3.5 μm and also reddens with KOH. The red reaction with KOH is distinct in all species so far described in *Hapalopilus* although it can fade in old specimens. Nevertheless, we feel that *H. tropicus* should be placed in this genus for the time being even if its pigment is different from polyporic acid which is responsible for the colour reaction with KOH in other *Hapalopilus* species. The genus is probably artificial, based entirely on this chemical reaction, a character that in all probability is convergent. This problem is now under examination with DNA sequencing.

Additional specimens examined. From the type locality, 1997, I.Lindblad: 2918 A, 2918 B.

HYMENOCHAETE UNGULATUS Burt

Fig. 3

Ann. Mo. Bot. Gard. 5:338, 1918.

Basidiocarps perennial, effused reflexed to ungulate, usually triquetrous in section with a sloping pileus, up to 1 cm wide, several cm long in fused specimens. Pileus black, glabrous and strongly sulcate with sharp margin. Hymenial surface smooth, dark umber brown. Subiculum up to 5 mm thick, umber brown, dense and distinctly stratified reflecting many years' or seasons' growth.

Hyphal system monomitic, generative hyphae hyaline to brown, simple septate, 2-3 μm wide.

Setae dark brown, acute, thick-walled, 35-45 x 6-7 μm .

Basidia clavate, 4-sterigmate, 9-12 x 4-5 μm , clamped at the base.

Basidiospores subglobose to broadly ellipsoid, hyaline, smooth, thin-walled, negative in Melzer's reagent, 2-2.5 x 3-3.5 μm .

Type of rot. White rot.

Substrate. On dead hardwoods.

Habitat. Collected in tropical moist montane forest.

Distribution. Known from the type locality in Mexico and the locality in Costa Rica for the specimen examined here.

Remarks. Previously, this species was only known from the sterile type (Leger 1998:281) and this is the first time a fertile specimen has been collected so its basidiospores could be described.

In the field this new species is easy to recognize because of the small unguulate basidiocarps with a glabrous, sulcate and black pileus, reminding one on sight of small specimens of the poroid *Datronia scutellata* (Schwein.) Gilbn. & Ryvarden, but with a smooth hymenium and grossly different microstructure

Specimen examined. Costa Rica, Guanacaste prov., Cacao, 1000 m, on dead deciduous tree, 1997, I.Lindblad 2568 (O).

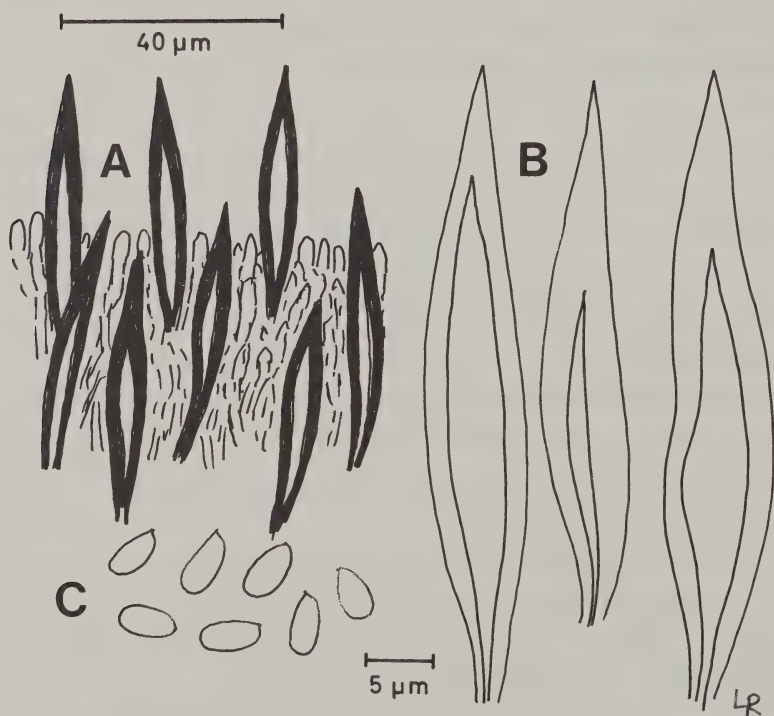


Fig. 3. *Hymenochaete unguolata* A) part of hymenium, B) setae, C) basidiospores. From I. Lindblad 2568.

INONOTUS XANTHOPORUS Ryvarden, **nova sp.**

Fig. 4

Fructificatio sessilis, pileus et porus brunneus, pori rotundis vel angulatis, 5-6 per mm, tubi et contextibus brunneis, systema hyphale monomiticum, hyphae generatoriae hyalinae vel brunnea, efibulatae, cum setis, basidiosporae ellipsoideae, 4-5 x 3-3.5 μm .

Holotype: Costa Rica, Volcan Barva, Send. Secreto, L. Umana, 16 April 1998, Herb. O. Isotype in Herb. INBio, Heredia, Costa Rica.

Etymology: Xanthus = yellow, porus = pores, refers to the yellow pore surface.

Basidiocarps annual effused reflexed, pileus semi-circular, up to 4 cm wide and 6 cm wide at base, applanate, slightly undulate, tough and hard. Upper surface rusty to dark brown, strongly scrupose with raised radial fibres to adpressed tomentose at the margin, azonate. Pore surface yellow, becoming cherry red with KOH, pores round to angular, 5-6 per mm, tubes pale cinnamon, 4 mm deep. Context cinnamon to pale rusty brown and dense, homogeneous and no cuticle visible in section, but in the upper part the hyphal orientation is vertical in contrast to that in the part next to the tubes.



Fig. 4. *Inonotus xanthoporus* A) setae, B) basidiospores. From the holotype.

Hyphal system monomitic, generative hyphae with simple septa, thin to thick-walled, golden to rusty brown, 3-7 μm wide.

Setal hyphae absent.

Hymenial setae numerous, dark brown, subulate 30-40 x 4-7 μm .

Basidia 10-12 x 5-6 μm with 4 sterigmata.

Basidiospores oblong ellipsoid, hyaline with large shiny oil drop, negative in Melzer's reagent, 4-5 x 3-3.5 μm .

Substrate. On unknown dead hardwood.

Distribution. Known only from the type locality.

Remarks. This new species has been checked against a key to all known species of *Inonotus* (Gilbertson & Ryvarden 1999) and no matching description has been found. It is undoubtedly related to *I. splitbergi* (Mont.) Ryvarden, another neotropical species, which however, lacks hymenial setae and has wider basidiospores. Both species react with a deep cherry red colour when touched by a drop of KOH.

JUNGHUHNIA MINUTA I. Lindblad & Ryvarden **nova sp.** Fig. 5

Fructificatio sessilis, pileus brunneus, pori albidis vel cremicolorbus, rotundis vel angulatis, 10-12 per mm, systema hyphale dimiticum, hyphae generatoriae hyalinae, fibulatae, cum cystidiis, basidiosporae ellipsoideae, 2.5-3 x 2-2.5 μm .

Holotype: Costa Rica, Guanacaste prov., Guanacaste National Park, Pitilla, 700 m, 30 January 1997, on dead hardwood, I. Lindblad 2621 (O), isotype in INB.

Basidiocarps annual, pileate, spatulate to fanshaped, single or imbricate in tiny clusters, up to 10 mm wide, 3-7 mm along the margin up to 1 mm thick, flat and tough when fresh, strongly bent and cartilaginous bony hard when dry, upper surface glabrous, azonate, somewhat furrowed radially due to considerable shrinkage during drying, pale reddish brown to resinous brown, pore surface white to pale ochraceous, pores round angular, thin-walled, 10-12 per mm and invisible to the naked eye, tubes up to 300 μm deep, context dense cartilaginous and pale brown, 100-300 μm thick.

Hyphal system dimitic; generative hyphae with clamps, hyaline, very difficult to observe due to the dense structure of the basidiocarp, 2-3 μm wide; skeletal hyphae abundant, hyaline to pale yellow, thick-walled, nonseptate, straight, 2-5 μm in diam.

Cystidia very abundant in the trama and the dissepiments, arising from skeletal hyphae, cylindrical to slightly clavate, upper part strongly encrusted, occasionally projecting into the hymenium, 30-60 x 7-10

µm.

Basidia clavate, 4-sterigmate, 6-8 x 3-4 µm, with a basal clamp.

Basidiospores ellipsoid to subglobose, hyaline, smooth, thin-walled, negative in Melzer's reagent, 2.5-3 x 2-2.5 µm.

Type of rot. White rot in dead hardwoods.

Substrata. Dead hardwoods, from unknown genera of hardwoods.

Distribution. Known only from Guanacaste province in Costa Rica, but certainly overlooked due to its minute size.

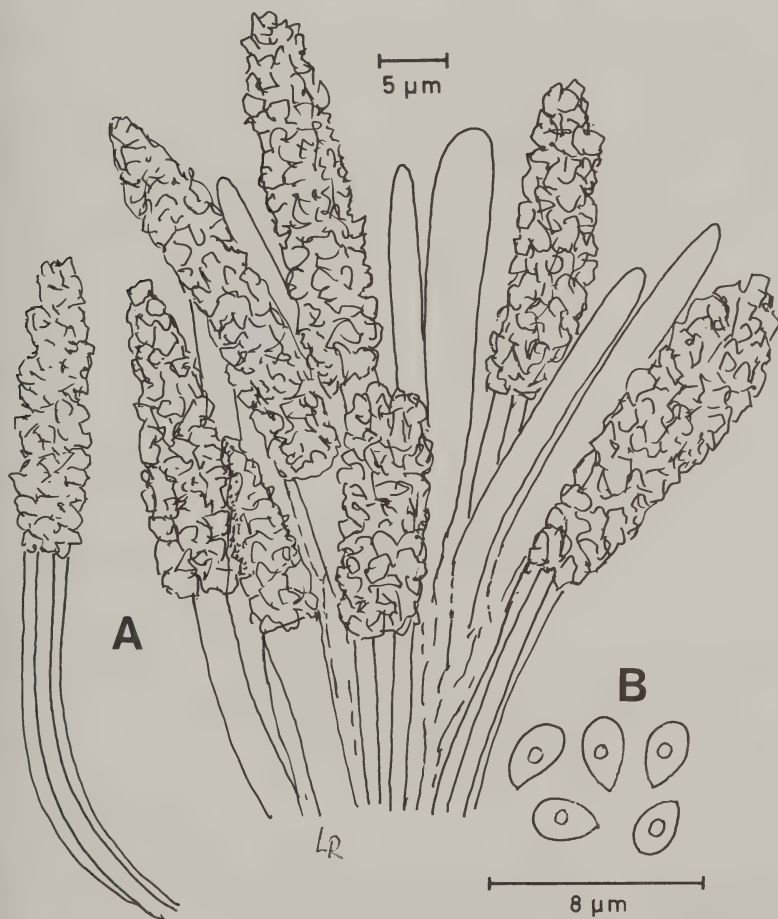


Fig. 5. *Junghuhnia minuta* A) cystidia from the dissepiments, B) basidiospores. From the holotype.

Remarks. The species is characterized by a tiny, glabrous, pale brown and dense basidiocarp, often with several small fanshaped basidiocarps

in clusters, and the tiny basidiospores.

Other pileate species from America all have larger basidiospores and basidiocarps.

Additional specimens examined: (from the type locality): I. Lindblad 2612A, 2623, 2637, 2648, 2691, 2979, 3534, 3552, 3570, 3571 and 3576(O).

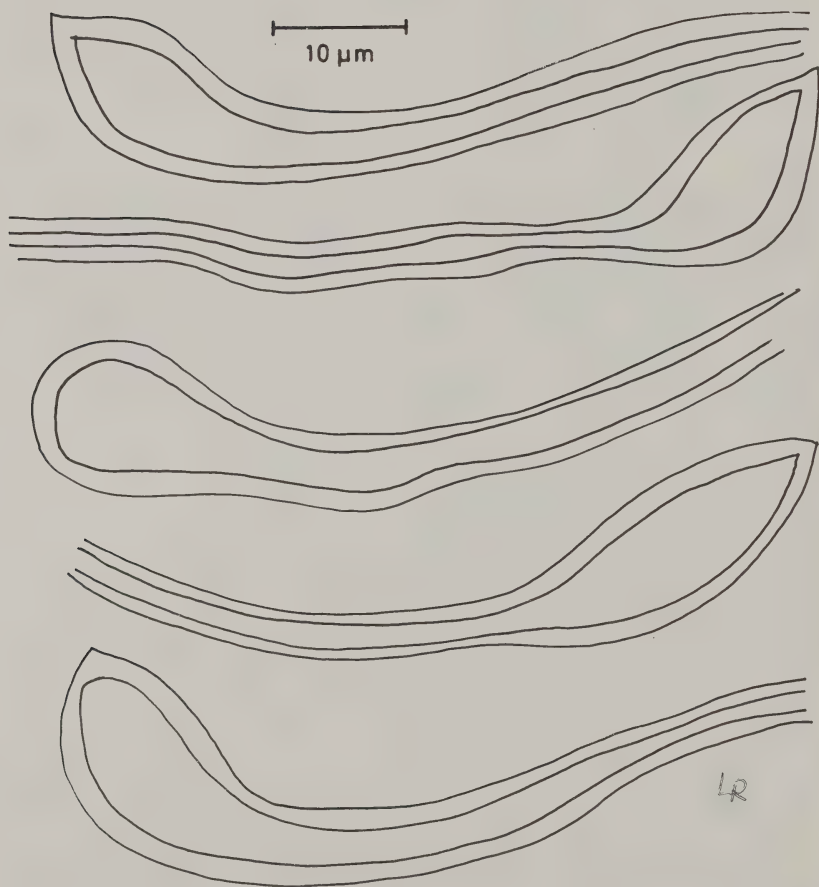


Fig. 6. *Junghuhnia neotropica*, cystidia from the hymenium. From the holotype.

JUNGHUHNIA NEOTROPICA I. Lindblad & Ryvarden **nova sp.**

Fig. 6

Fructificatio sessilis, pileus brunneus, pori albidis vel cremicoloribus, rotundis vel angulatis, 8-10 per mm, systema hyphale dimiticum, hyphae generatoriae hyalinae, fibulatae, cum cystidiis, basidiosporae ellipsoideae, 2.5-3 x 2-2.5 μ m.

Holotype: Costa Rica, Guanacaste prov., Guanacaste national Park, Pitilla, 700 m, 20 October 1997, on dead hardwood, I. Lindblad 3395 (O), isotype in INB.

Basidiocarps annual, pileate, spatulate to fanshaped, single, up to 10-12 mm wide, 8-10 mm along the margin, up to 1.2 mm thick, flat and tough when fresh, strongly bent and cartilaginous bony hard when dry, upper surface glabrous, azonate, smooth, yellowish brown, pore surface white to pale ochraceous, pores round angular, thin-walled, 8-10 per mm and invisible to the naked eye, tubes up to 1.3 mm deep, context dense cartilaginous and pale yellowish brown up to 0.5 mm deep.

Hyphal system dimitic; generative hyphae with clamps, hyaline, very difficult to observe due to the dense structure of the basidiocarp, 2-4 μ m wide; skeletal hyphae abundant, hyaline to pale yellow, thick-walled to solid, nonseptate, straight, 2-5 μ m in diam.

Cystidia smooth with an elongated base and a swollen ventricose, pointed to rounded apex, partly bending into the hymenium, but also embedded in the trama, up to 120 μ m long, apex 25-40 x 12-20 μ m.

Basidia clavate, 4-sterigmate, 6-8 x 3-4 μ m, with a basal clamp.

Basidiospores ellipsoid to subglobose, hyaline, smooth, thin-walled, negative in Melzer's reagent, 2.5-3 x 2-2.5 μ m.

Type of rot. White rot in dead hardwoods.

Substrata. Dead hardwoods from unknown genera.

Distribution. Known only from Guanacaste province in Costa Rica, but certainly overlooked due to its minute size.

Remarks. The species is characterized by a tiny, glabrous, pale yellowish brown and dense basidiocarp, tiny basidiospores and smooth apically ventricose cystidia which we have not seen in any other *Junghuhnia* species.

Macroscopically it is similar to *J. minuta*, described above, which however has tiny, thin often partly split basidiocarps and numerous club shaped encrusted cystidia in the trama and the dissepiments. The basidiospores are seemingly identical in the two species.

Additional specimen examined: From the type locality: I. Lindblad 2322, 2411, 2617, 2654, 2877A, 2881-B, 2976 and 3568 (O).

PILOPORIA ALBOMARGINATA (Lév.) Ryvar den **comb. nov.**

Basionym: *Polyporus albomarginatus* Lév., Ann. Sci. Nat. Ser. 3, Vol. 2:191, 1844 - *P. kermes* Berk. & Broome, J. Linn. Soc. Bot. 14:49, 1875 - *P. laeticolor* Berk., J. Linn. Soc. Bot. 16:46, 1877 - *Fomes pyrohoceas* Cooke, Grevillea 14:11, 1885 - *Polyporus purpureoaurantiacus* Beeli, Bull. Soc. Bot. Belg. 62:64, 1929 - *Piloporia indica* Ganesh, Leelavathy & Ryvar den, Trans. Br. Mycol. Soc. 91:169, 1988.

Basidiocarps annual to perennial, effused-reflexed and orbicular to distinctly pileate and then mostly imbricate, elongated, semicircular to dimidiate, up to 8 cm wide to 20 cm long in laterally fused specimens, 2-4 cm thick at the base, coriaceous to hard when dry. Pilear surface first reddish golden, azonate to zonate with a few slightly sulcate zones, appressed velutinate or slightly scrupose, with age the upper tomentum is agglutinated and a distinct dark brown to black cuticle is developed. Margin often paler than the inner parts of the pileus. Pore surface pale orange, glancing when turned in incident light, with age and in old specimens brick-red with brownish tints, in old basidiocarps the pore surface frequently recedes, leaving zones of sterile areas along the margin, pores 4-5 per mm, angular, tubes whitish, single-layered to stratified, single layers up to 3 mm thick, together up to 1.5 cm long, dissepiments farinose. Context bright orange to brick-red, dense with age, more soft in the upper part in young specimens, frequently with thin, black lines reflecting earlier growth, purplish with KOH.

Hyphal system dimitic, generative hyphae with clamps, hyaline and 2-4 μm wide, often difficult to find. Skeletal hyphae reddish brown, distinctly more cherry-red when mounted in KOH, thick-walled to solid, straight, up to 6 μm wide, in the trama parallel and more thin-walled than in the context where they are randomly oriented.

Cystidia absent; hyphoid cystidiols common in the tubes in sterile specimens.

Basidia clavate, 6-8 x 2.5-3.5 μm , 4-sterigmate.

Basidiospores allantoid, hyaline, smooth, 3-4 x 0.5-0.8 μm .

Substrate. On hardwoods.

Distribution. Tropical species, widespread from Japan to Zaire and now reported for the first time from tropical America.

Remarks. Previously (Ryvar den & Johansen 1980:529) this species was placed in *Pyrofomes* Pouz. because of its brick red context and trama. Numerous specimens were examined without a trace of basidiospores, but they may have been overlooked because of their tiny size and because the attention was focused on looking for the typical

thick-walled, truncate basidiospores of *Pyrofomes*. Later on, a richly fertile specimen was received from India and its proper place in *Piloporia* was acknowledged. It was described as new without comparison with the so-called sterile specimens of *Polyporus albomarginatus* (Ganesh, Leelavathy & Ryvarden 1988), but some years later additional fertile specimens were collected in Japan, and this time the connection to *P. albomarginatus* was made.

The species clearly belongs in *Piloporia* because of its tiny allantoid basidiospores, the black lines in the context, and the dimitic hyphal system with finely encrusted hyphae in the dissepiments.

Undoubtedly, *Piloporia* is closely related to *Skeletocutis* Kotlaba & Pouzar, which includes species with tiny allantoid basidiospores and finely encrusted skeletal hyphae in the dissepiments. However, in *Piloporia* the context is duplex and dark brown in the type species, i.e. *P. sanjanensis* (Parmasto) Niemelä, strongly contrasting with the cream coloured tubes from which it is separated by a black line. Such characters are not seen in *Skeletocutis* and thus we are not prepared to merge the two genera.

Specimens examined. Costa Rica, Estac. Biologica Pitillo, Send. Loaciga, 11. April 1997, C. Cano 1034 (O), Indonesia, Java, lectotype of *P. albomarginatus* Lév. (PC).

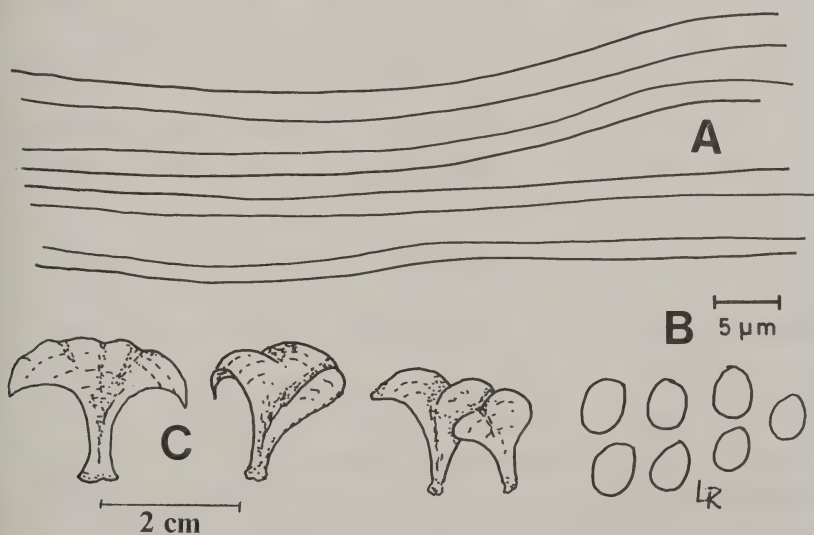


Fig. 7. *Rigidoporus mutabilis* A) skeletal hyphae from the trama, B) basidiospores, C) basidiocarps. from the holotype.

RIGIDOPORUS MUTABILIS I.Lindblad & Ryvarden **nova sp.** Fig. 7
Fructificatio sessilis, pileus et porus cinereus vel brunneus, pori rotundis vel angulatis, 2-3 per mm, systema hyphale monomiticum, hyphae generatoriae hyalinae, efibulatae, basidiosporae globosae, 3-4 μm diametro.

Holotype: Costa Rica, Guanacaste prov., Pitilla, 700 m, 25 May 1997, on dead deciduous tree, I.Lindblad 2910 A, in O. Isotype in Herb. INB, Heredia, Costa Rica.

Etymology: Mutabilis = changeable, referring to the striking difference from white to deep brown when dry.

Basidiocarps annual, pileate, laterally stipitate, becoming almost centrally stipitate when rear part of the pilei fuse, single or in clusters and then often fused to rosette-like or funnel shaped structures, consistency soft and fleshy when fresh, brittle, hard and bent when dry. Pileus 1-2 cm wide, fanshaped to semicircular, upper surface glabrous, smooth, zonate, white with radial, zonewise pale grey or brown, drying dark grey to reddish brown with distinct zones. Margin straight and thin when dry, strongly deflexed when dry, stipe up to 6 mm high and 3 mm wide, tapering towards the base, glabrous, very finely adpressed velutinate, ochraceous and much lighter than the pileus surface. Pore surface white, peach coloured to saffron when fresh drying ochraceous to pale straw coloured, pores round to angular, 8-10 per mm, dissepiments very thin, tubes up to 2 mm long, translucent and dense when dry. Context white to ochre, up to 2 mm thick and homogeneous.

Hyphal system monomitic, generative hyphae with simple septa, thin-to slightly thick-walled, 3-5 μm wide, in the context and trama thick-walled up to 8 μm wide with few scattered septa.

Cystidia not present

Basidia 10-125 x 7-8 μm 4-sterigmate and with a simple septum at the base.

Basidiospores globose, hyaline, thin-walled, negative in Melzer's reagent, 3-4 μm in diameter.

Type of rot. White pocket rot in dead hardwoods.

Substrate. On dead hardwoods

Habitat. Collected in tropical moist forest.

Distribution. Besides the type locality also collected in Cacao and Rincon de la Viecha (Santa Maria), both in the Guanacaste Conservation Area, Guanacaste province, Costa Rica.

Remarks. This is a remarkable species with its strong colour change from almost white when fresh to reddish brown when dry, at the latter

stage reminding one of other *Rigidoporus* such as *R. microporus* (Fr.) Overeem. The basidiocarps are distinct not only by their colour, but also by being small, semicircular and with a small lateral stipe. Such a lateral stipe is also known in *R. amazonensis* Ryvarden, which however, has a much larger basidiocarp and a velutinate adpressed upper surface, where the tomentum is separated from the context proper by a thin dark line.

A remarkable character is the distinct pocket rot in the wood behind the basidiocarps. As far as we can see from available literature, such a rot has previously not been reported from *Rigidoporus*.

R. mutabilis was found over a period of two weeks occurring in large numbers on more than 20 logs, but was never seen again on the same logs. It is therefore seemingly an ephemeral species to be found only during short periods of suitable climatic conditions, i.e. after one to two months' dry spell in the rain forest.

Additional specimens examined. From the type locality, 1997, I.Lindblad: 2844 B, 2878 A, 2880 F, 2882 C, 2883 B, 2888 B, 2896 C, 2911 A, 2912 A, 2915 A, 2951 A, 2955 A, 2983 B. Costa Rica, Guanacaste prov., Guanacaste Nat. Park, Cacao, 1997, I.Lindblad: 2810, 2813, 3021, 3041. Costa Rica, Guanacaste prov., Rincon de la Viecha Nat. Park, Santa Maria, 1997, I.Lindblad: 2853, 2854.

TRAMETES CYSTIDIATA I.Lindblad & Ryvarden **nova sp.** Fig. 8
Fructificatio sessilis, pileus et porus albidus vel cremeus, pori rotundis vel angulatis, 0.5-1 x 1-2 mm, tubi et contextibus albidis, systema hyphale trimiticum, hyphae generatoriae hyalinae, fibulatae, cum cystidiis, basidiosporae cylindricae vel ellipsoideae, 4.5-5 x 2-2.5 μ m. Holotype: Costa Rica, Guanacaste prov., Pitilla, 700 m, 23. March 1997, on dead deciduous tree, D. Garcia, INB, Isotype in O.
Etymology: Cystidiata, referring to the numerous cystidia.

Basidiocarps annual to perennial, flabelliform, dimidiate or circular, sessile or with a short stipe-like base, 1-20 cm wide and long and 0.2-2 cm thick, corky and flexible when fresh, more rigid when dry. Upper surface white, cream to pale ochraceous, in some specimens with a black cuticle spreading from the base, surface very finely tomentose, soon glabrous, smooth or concentrically sulcate, often warted or with slightly uneven elevated areas and in some specimens with a mycelial outgrowth spreading irregularly from the base. Margin thin, but not deflexed, even or lobed, stipe absent, but base in some specimens strongly contracted and attached to the substrate with a disc. Pore surface pale cream, pores round to angular, many radially elongated, in

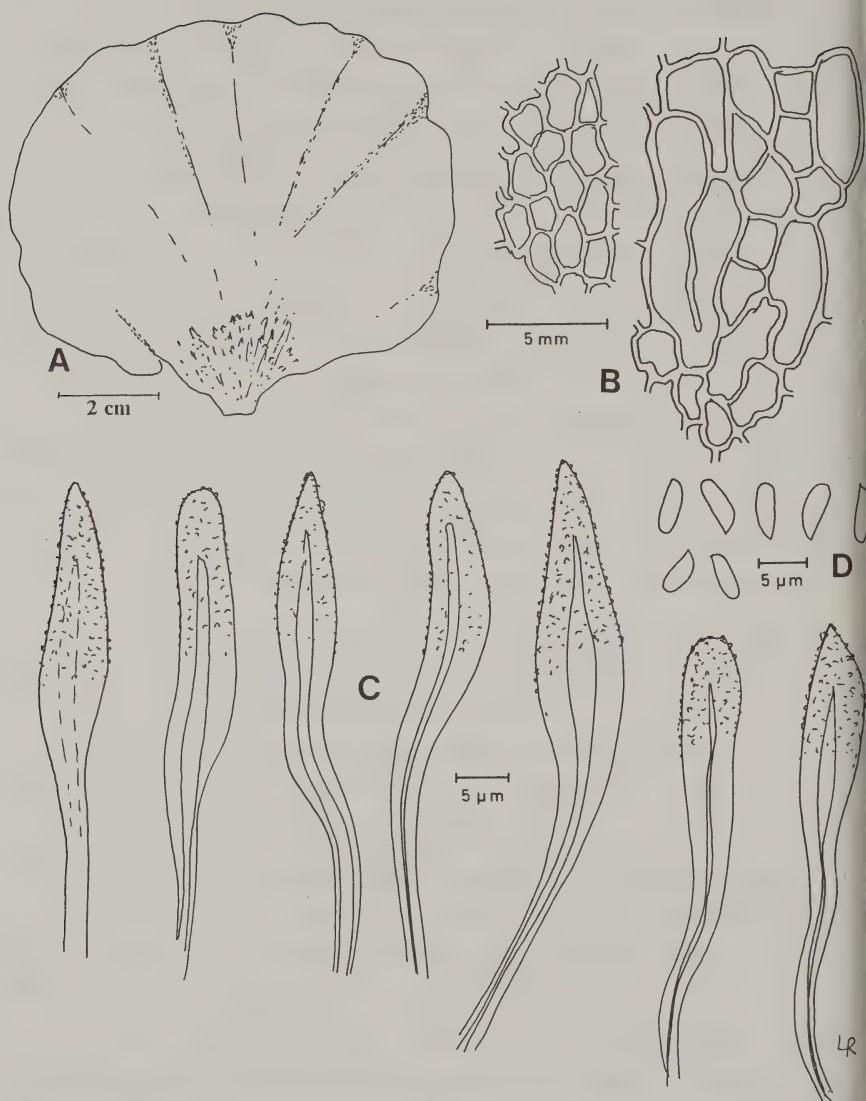


Fig. 8. *Trametes cystidiata* A) basidiocarp from above, B) pores, C) cystidia, D) basidiospores. From the holotype.

older specimens partly split and slightly irregular, up to 8 mm long and 1-4 mm wide, tubes or lamellae up to 10 mm deep. Context white to pale cream, up to 5 mm thick near the base, woody hard when dry.

Hyphal system trimitic, generative hyphae hyaline, delicately thin-walled, with clamps, 2-4 μm wide. Skeletal hyphae dominating, yellow to golden, thick-walled to solid, 3-8 μm in diameter. Binding hyphae only in the trama, rather rare, hyaline to pale yellow, thick-walled, up to 3 μm wide, irregularly branched.

Cystidia present in the hymenium and dissepiments as skeletocystidia, pointed to round, apically very finely encrusted, up to 10 μm diam. in the widened part, of indeterminate length, hyaline, thick-walled and without reaction in Melzer's reagent.

Basidia clavate, 4-sterigmate, 10-14 x 4-6 μm , with a basal clamp.

Basidiospores cylindric to oblong ellipsoid, hyaline, negative in Melzer's reagent, 4.5-5 x 2-2.5 μm .

Type of rot. White rot.

Substrate. On dead hardwoods.

Habitat. Collected in tropical wet forest.

Distribution. Known only from the type locality.

Remarks. From above, the basidiocarps of this species looks like those of the common *Trametes elegans* (Spreng.:Fr.) Fr., which however has smaller pores, often daedaloid to sinuous or even almost completely lamellate. Further, the finely encrusted cystidia seen in *T. cystidiata* are unknown in the genus. Similar structures can be seen in *Trametes cubensis* (Mont.) Sacc., but in this species the cystidia originate as apically smooth, sharply pointed parts of binding hyphae, thus grossly different from the cystidia described here. Additionally *T. cubensis* has much smaller pores, hardly visible to the naked eye.

Additional specimens examined. From the type locality, 1997, I.Lindblad: 2424, 2655, 2661, 2662, 2689, 2942 A, 3585.

WRIGHTOPORIA EFIBULATA I.Lindblad & Ryvarden **nova sp.**

Fig. 9

Fructificatio resupinata, porus albidus, pori rotundis 6-8 per mm, tubi et contextibus aurantiacis, systema hyphale dimiticum, hyphae generatoriae hyalinae, efibulatae, hyphae skeletales hyalinae, basidiosporae globosae, amyloideae, verrucosae, 3-3.5 μm diametro.

Holotype: Costa Rica, Guanacaste prov., Guanacaste national park, Cacao, 1000 m, 29 October 1997, on dead hardwood, I.Lindblad 3607 Herb. O. Isotype in INB, Heredia, Costa Rica.

Etymology: Efibulatae -refers to the simple septate generative hyphae.

Basidiocarp annual, resupinate, up to 1 mm thick, easily separable from the substrate, consistency soft when fresh, brittle when dry. Margin white to buff, cottony, irregular, sterile. Pore surface white with a rose tint when fresh, white, buff to rosy buff when dry, pores round, entire, thin-walled, slightly irregular in size, 6-8 per mm; tube layer concolorous with pores, up to 0.5 mm long; subiculum thin, up to 0.5 mm.

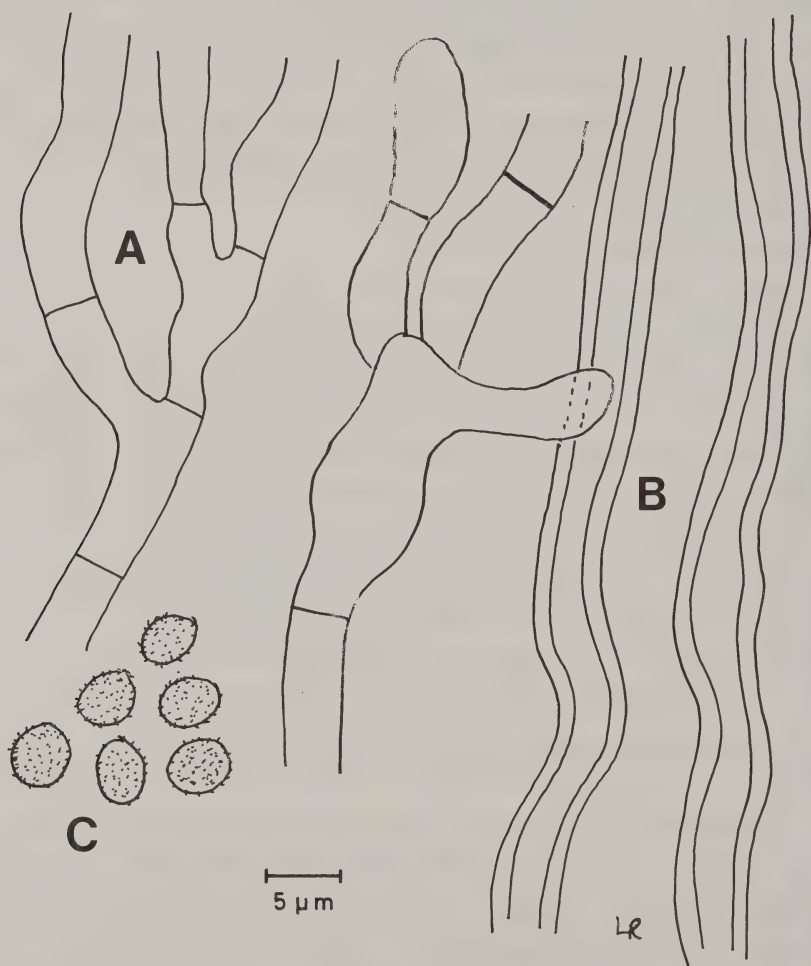


Fig. 9. *Wrightoporia efibulata* A) generative hyphae B) skeletal hyphae, C) basidiospores. From the holotype.

Hyphal system dimitic, generative hyphae hyaline, thin-walled, with simple septa, 3-8 μm wide. Skeletal hyphae thick-walled to solid, hyaline, negative in Melzer's reagent, sinuous, 4-8 μm wide.

Cystidia and other sterile hymenial elements absent.

Basidia not seen.

Basidiospores globose, hyaline, very finely asperulate, thin-walled, amyloid, 3-3.5 μm in diam.

Type of rot. White rot.

Substrate. On dead hardwoods.

Habitat. Collected in tropical moist forest.

Distribution. Known only from the type locality.

Remarks. The species is recognized by the small pores, the whitish adnate basidiocarp and above all by the consistently simple-septate generative hyphae and non-dextrinoid skeletal hyphae.

In Stalpers key to the genus (Stalpers' 1996) this new species would key out with *Amylosporus braceii* (Murrill) David & Rajchenberg, which however, has a pinkish-violaceous, easily detached basidiocarp and ellipsoid basidiospores.

We are of the opinion that this pinkish resupinate species is better placed in *Wrightoporia* than in *Amylosporus*, which is typified by *Polyporus campbellii* Cooke, a white stipitate species. Thus, we propose the following combination: *Wrightoporia braceii* (Murrill) I. Lindblad & Ryvar den **comb. nov.** Basionym: *Poria braceii* Murrill, Mycologia 13:91, 1921.

Additional specimens examined. From the type locality, 1997, I.Lindblad: 3013, 3018 B and 3606.

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STUDIES IN NEOTROPICAL POLYPORES 4* NEW AND NOTEWORTHY SPECIES FROM COIBA NATIONAL PARK, PANAMA

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ABSTRACT

19 species new to Coiba National Park are reported and out of these 7 are new to Panama while *Rigidoporus dextrinoideus* Johansen & Ryvarden is new for America. *Antrodiella reflexa* Núñez & Ryvarden and *Macrohyporia pileata* Núñez & Ryvarden are described as new.

Key words: Polyporaceae, Panama.

INTRODUCTION

This is the second paper reporting polypores from Coiba National Park (Núñez 1997). The national park is located on Coiba island in the Pacific Ocean, 25 km southeast of Panama. The area of the island is about 50.000 ha., and 70% of its vegetation is still virgin. Several biodiversity studies have recently been undertaken (Pérez et al. 1996, Castroviejo 1997) with the aim to establish a permanent Panamanian-Spanish biological station in the National Park. In the first paper totally 105 species were reported. In this paper, more polypores new to the island are reported, and three new species are described. Collecting and methods are as described in the first paper. The collections are deposited at MA with duplicates at O.

* For previous papers in this series, see under References.

CORTICIACEAE

Grammothele lineata Berk. & M.A. Curtis
Rio Escondido, 13.4.97 (MN339).

Schizopora paradoxa (Fr.) Donk
Rio Escondido, 13.4.97 (MN349).

HYMENOGAETACEAE

Aurificaria luteo-umbrina (Romell) D.A. Reid
From Playa Hermosa to Station Clara, 22.11.96. MN218, on
Podocarpus sp.

Remarks: This is a resupinate specimen of an otherwise pileate species. The collection is the first record of this species from a gymnosperm.

Phellinus membranaceus J.E. Wright & Blumenf.
Cerro de la Equis, 14.11.96 (MN1), Ensenada de Sta. Cruz, 17.11.96 (MN80, MN100).

Remarks: Wright & Blumenfeld (1984) described the species as annual. However, most of the specimens we have found in Coiba are perennial, several with up to 5 tube layers. New to Panama.

Antrodiella hydrophila (Berk. & M.A. Curtis) Ryvarden
Rio Escondido, 13.4.97 (MN 353).

Antrodiella incrustans (Cooke) Ryvarden
Juncal, 18.11.96 (MN138), From Playa Hermosa to Sta. Clara, 22.11.96 (MN229, MN234), Rio Negro, 19.11.96 (MN162).

Remarks: The species was identified as *Antrodia* cf. *crassa* in Núñez (1997), as it assumed to be a brown-rot fungus. A careful reexamination of all collections has led to a renaming of the specimens. New record for Panama.

Antrodiella reflexa Ryvarden & Núñez, nov. sp. Fig. 1 A-B
Fructificatio sessilis, pileus ochraceus, pori rotundis vel angulatis, 8-10 per mm, albidis vel cremicoloribus, systema hyphale dimiticum, hyphae generatoriae, fibulatae, basidiosporae ellipsoideae, 3.5-4 x 2.5-3 µm.

Holotypus: Panamá, Juncal, 18.11.96, Coiba National Park, leg. M. Núñez no 130 (O). Isotype in MA.

Basidiocarps pileate, annual, effused, reflexed to sessile, rarely dimidiate, applanate and tough when fresh, curled, hard and rigid when dry, up to 3 cm wide and long, 2-5 mm thick, upper surface glabrous, smooth when fresh, slightly wrinkled when dry, slightly zonate, ochraceous to pale yellowish brown with a red cuticle spreading from the base, margin sharp, pore surface white to cream, pores tiny invisible to the naked eye, 8-10 per mm, 1-2 mm deep, context thin, dense and white, 1-2 mm thick.

Hyphal system dimitic; generative hyphae with clamps, hyaline, thin-walled, branched, in the subiculum 2-3 μm wide, skeletal hyphae thick-walled to solid, hyaline, 2-5 μm .

Cystidia absent.

Basidia clavate, 4-sterigmate, 12-15 x 5-6 μm , with a basal clamp.

Basidiospores ellipsoid, hyaline, smooth, negative in Melzer's reagent, 3.5-4 (4.3) x 2.5-3 μm .

Substrata. Known from dead deciduous wood.

Distribution. Besides the type locality also known from Puerto Rico and Venezuela.

Remarks. This species is characteristic with dense basidiocarps and a red cuticle spreading from the base, the latter characteristic is not known from any other *Antrodiella* species as far as we know. *A. semisupina* (Berk. & M. A. Curtis) Ryvarden is closely related, but has smaller basidiospores and do not develop a red cuticle at the pileus.

Specimen examined. USA, Puerto Rico, Municipio Isabella, Quebradillas, 27. June 1996. Ryvarden 39111 (O)

Daedalea aethalodes (Mont.) Rajchenb.

Ensenada de Sta. Cruz, 17.4.97 (MN382). New to Panama.

Fomitopsis rhodophaea (Lév.) Imazeki

Cerro de la Equis, 12.4.97 (MN301).

Hexagonia papyracea Berk.

Jicarón, North beach, 16.4.97 (MN379).

Macrohyporia pileata Ryvarden & Núñez, nov. sp. Fig. 1 C-D
Holotypus: Juncal, 18.11.96, Coiba National Park, Panama, leg. M. Núñez 125 (O), isotype in (MA).

Fructificatio sessilis, pileus brunneus, pori albidis vel cremicoloribus, rotundis vel angulatis, 2-3 per mm, systema hyphale monomiticum, hyphae generatoriae hyalinae, efibulatae, basidiosporae elipsoideae, 5-6 x 4-4.5 μm .

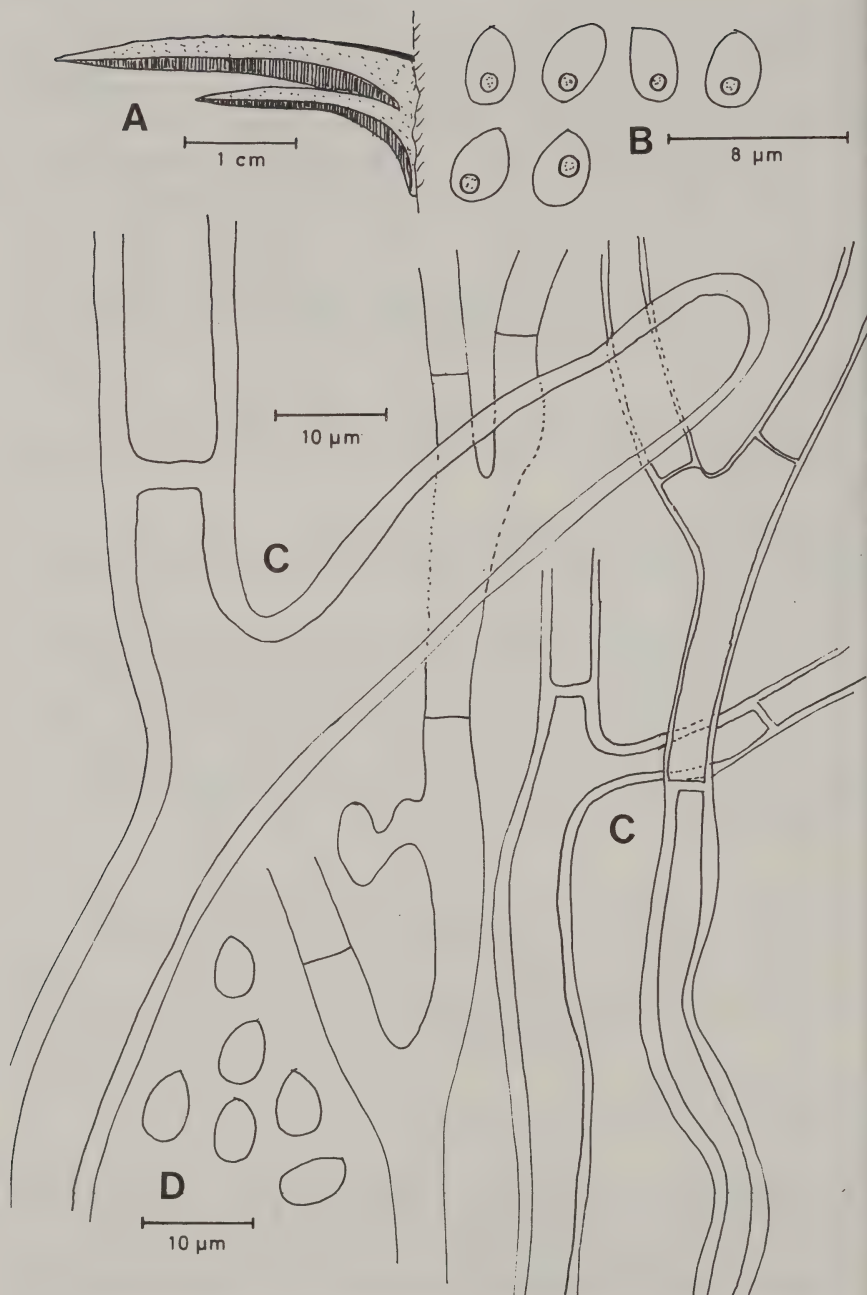


Fig. 1 *Antrodiella reflexa* A) section of basidiocarp, B) basidiospores. *Macrohyporia pileata* C) generative hyphae, D) basidiospores. From the holotypes.

Basidiocarp annual, pileate, nodulose with sloping pileus, up to 3 cm from base to margin, up to 5 cm wide and 4 cm thick at the base, upper surface glabrous, dull, concentrically sulcate in shallow zones, slightly undulating radially, dark brown with a distinct black crust, reminding about that seen in *Ganoderma australe*, pore surface pale straw-coloured, pores angular, close to the margin radially elongated 1-3 per mm, tubes concolorous, up to 4 cm deep, context dense and white, up to 4 mm deep.

Hyphal system monomitic; generative hyphae with simple septa, hyaline, in the trama, 2-7 μm wide, in the context to 18 μm wide with thick walls, negative in Melzer's reagent.

Cystidia absent.

Basidia clavate, 4-sterigmate, 18-25 x 5-6 μm , with a basal clamp.

Basidiospores ellipsoid to subglobose, hyaline, smooth, thin-walled, negative in Melzer's reagent, 5-6 x 4-4.5 μm .

Type of rot. White rot in dead hardwoods.

Substrata. Dead hardwoods of unknown identity.

Distribution. Known only from the type locality.

Remarks. This new species is highly characteristic by its large pores, dark brown to black, strongly indurated cuticle, both in structure and appearance reminding one strongly about the pileus of *Ganoderma australe* (Fr.) Pat and similar species. Microscopically, the very wide simple septate hyphae are distinct and this character is the main reason for placing the species in *Macrohyporia*. The genus is typified by *Macrohyporia dictyopora* (Cooke) Ryvar den (for a description, see Ryvar den & Johansen 1980: 422) which has a similar hyphal structure and basidiospores, but has a resupinate basidiocarp.

Perenniporia medulla-panis (Fr.) Donk

Rio Escondido, 13.4.97 (MN350).

Piptoporus soloniensis (Dub.:Fr.) Pilát

Cerro de la Equis, 12.4.97 (MN303).

Polyporus grammocephalus Berk.

Rio Escondido, 13.4.97 (MN348).

Rigidoporus dextrinoideus I. Johans. & Ryvar den

Cerro de la X, 12.4.97 (MN332).

Remarks: Previously not known in America. The species was described from Africa (Ryvar den & Johansen 1980).

Rigidoporus vinctus (Berk.) Ryvarden var. *cinerea*
Rio Escondido, 13.4.97 (MN356).

Skeletocutis diluta (Rajchenb.) David & Rajchenb.

First quebrada from Aguas Termales to Rio Negro, 50 m. 19.11.1996 (MN191), Juncal (MN 128, 142 and 189) on *Manilkara zapota* and *Calophyllum brasiliensis*.

The species was described from Northern Argentine (Rajchenberg 1983) and then later reported from West Africa (David & Rajchenberg 1992 in which a detailed description can be found). Thus, this report is the first from Central America.

Tyromyces hypocitrinus (Berk.) Ryvarden

Rio Escondido, 13. April 1997 (MN 347).

Remarks. This is a rare neotropical species with distinct yellow pore surface and hymenial gloeocystidia. Previously known only from Brazil (type locality) and Costa Rica (Ryvarden 1984, Núñez 1996).

Tyromyces xuchilensis (Murrill) Ryvarden

Juncal, MN115, 18 November 1996.

Remarks: This is the second world record of this species, which was described from Mexico. It is characterized by papery thin, pileate white basidiocarps and globose basidiospores (For a description, see Ryvarden 1985).

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BIOSYSTEMATICS OF DIDYMIUM: THE NON-CALCAREOUS, LONG-STALKED SPECIES

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Abstract: The non-calcareous, long-stalked species of *Didymium* are traditionally placed in four or five relatively common and cosmopolitan morphospecies, with several additional very rare taxa. However, culture studies indicate that this group is divided up into regionally based heterothallic biological species and numerous nonheterothallic (presumably apomictic) lines that share most of the characteristics upon which the morphospecies are based. Therefore, all of the morphospecies are assigned to three species complexes. The *Didymium megalosporum* and *D. ovoideum* complexes are basically redefined morphospecies, while the *D. iridis* complex incorporates all of the remaining members of this group.

Key Words: biological species, myxomycetes, heterothallism, slime molds.

INTRODUCTION

The myxomycetes are an ancient protistan lineage (Johansen et al., 1988, 1992) in which the ancestral life cycle and developmental plan are relatively fixed. While this helps to delimit the higher taxonomic categories into well defined discrete groupings, there can be difficulties at the species level, where taxa are often distinguished on the basis of relatively small morphological variations found in the sporangia. For example, the non-calcareous, long-stalked *Didymium* cluster has been divided into five (Martin and Alexopoulos, 1969) or nine species (Nannenga-Bremekamp, 1972) based on various combinations of sporangial traits. On the other hand, mating studies have shown that there is a minimum of eight reproductively isolated breeding groups as well as numerous nonheterothallic lines in this cluster (Betterley and Collins, 1983; Clark et al., 1991; Clark and Landolt, 1993; Clark and Stephenson, 1990, 1994). However, only the A0 mating series (Va 1, Va 2, Va 3, Va 4, Va 5, Va 6, Va 7, Va 8, Va 9, Va 10, WV 1, WV 2, WV 3, WV 4) was found to correlate with a recognized morphospecies, *D. ovoideum* Nann.-Brem., which is also the most distinctive, since it has a yellow plasmodium rather than one of the brown plasmodial types found in the rest of the cluster. The other seven mating series appear to be geographically based, with the A1 series (CR 1, CR 2, CR 5, CR 6, CR 8, Gua 1, Hon 1, Ia 1, NY 1, Pan 1, Pan 2, Pan 3, Pan 8) in Central America

(one known and one possible immigrant to the U.S.), A2 (Ky 1, Va 1) in the northeastern U.S., A3 (Wa 1) in the northwestern U.S., A4 (Pan 4) in Central America (a revertant from apomixis), A5 (Ga 2, Mex 1, Mex 2, Mex 3) in Mexico and the southeastern U.S., A6 (Fla 1) in the southeastern U.S., and A7 (GB 1) in Europe. The nonheterothallic isolates (Ca 1, Ca 2, Ca 3, Ca 4, Ca 5, Ca 6, Ca 7, Ca 8, CR 3, CR 4, CR 7, Fr 1, Ga 1, Gau 2, Ha 1, Ind 1, Jap 1, Ks 1, Mn 1, Mn 2, Mn 3, Mn 4, Mn 5, Mn 6, Mo 1, NC 1, Pan 5, Pan 6, Pan 7, Ph 1, SA 1, SA 2, Tx 1, Tx 2) have a world wide distribution, but are especially prevalent on islands, in cool or dry areas, and in regions that are distant from Central America. Isozyme studies on some of these isolates indicate that there is relatively little isozyme variation within each mating series but that the different mating series and nonheterothallic lines each display distinct patterns (Betterley and Collins, 1983). The rest of the mating series, outside of *D. ovoideum*, do not correlate with any of the morphologically defined species in that most key characteristics, considered as defining for particular species, occur within several mating series. Since most of the narrowly defined morphospecies have a cosmopolitan distribution, while the morphologically variable biological species (mating series) are generally geographically isolated, there is a major dichotomy in species concepts for this cluster that needs to be resolved.

MATERIALS AND METHODS

Sporangia from previous studies of reproductive systems (Clark et al., 1991; Clark and Landolt, 1993; Clark and Stephenson, 1990, 1994) provided the material for this study. This material consisted of sporangia from the various isolates, hybrids from crosses between various isolates, and progeny from these hybrids. For each isolate, a representative sample of sporangia was examined for morphological variations that could be attributed to genetic and/or cultural effects. Some of these morphological variations were then examined in hybrid sporangia and their progeny to determine the inheritance, if any, of these characters.

The morphological characters examined included: spore size and ornamentation, capillitium color and branching, lime crystal size and morphology, stalk color and proportion, overall sporangial size and proportion, and columella shape, size and color. The characteristics of the columella were examined in considerable detail since these traits are relatively easy to distinguish and they are often used as major species characters in this genus. Sporangia were embedded in wax, sectioned with a Fisher knife, observed with dissecting and compound microscopes, and the characters recorded with detailed line drawings. Color determinations were made with Munsell color charts for plant tissues (1977), with color names standardized with the ISCC-NBS method of designating colors (Kelly and Judd, 1965).

RESULTS

Morphological variations There is a considerable amount of variation within isolates in all of the cultures. In general, poor sporangial development, either caused by culture conditions or innate to a particular genotype, produced darker colors and amorphous lime. Also, there is a possible overall two fold size difference between sporangia in the same culture. The measurements provided for the following traits are averages for each

isolate from a minimum of twenty arbitrarily selected sporangia.

Sporangial shape The sporangia of all of the isolates were depressed-globose, with the exception of the A0 mating series isolates, which varied from nearly globose to slightly prolate, and one nearly globose isolate (CR 2) of the A1 mating series. Sporangia were always umbilicate below (see columella) and occasionally umbilicate above, but this is apparently a developmental variation that is more common in some isolates. Sporangia in the various isolates ranged from 0.28 to 0.50 mm in diameter with most in the 0.30-0.35 mm range. Each reproductive group (mating series or nonheterothallic line) having a reasonable sample size displayed a full range of size variation, with only the A5 series tending towards the larger end of the scale.

Peridium The peridium of all isolates is membranous and, with few exceptions, colorless to tinged with light brown pigment. While most of the isolates normally have colorless peridia and only produce darker colorations under poor sporulation conditions, the non-heterothallic Ca 8 and Tx 1 isolates have light yellowish brown colored peridia even under normal conditions.

Lime Extremely variable lime crystals are produced under normal laboratory culture conditions. Size (1 to 18 μ) and shape (amorphous clusters to stellate crystals) vary greatly within each isolate and are generally dependent upon substrate, transpiration and sporangial development (with the well-developed sporangia having the more distinctive crystal forms). Under these condition, consistent differences in lime characteristics could not be detected. However, some isolates, while variable, were consistently better lime producers than others, and *Didymium ovoideum* isolates tended towards a cuboid crystal form.

Capillitium All isolates have delicate, branching, anastomosing, colorless to light-brown capillitial threads. One nonheterothallic isolate (Ca 8) tended towards the darker end of the color scale, the A0 mating series (*D. ovoideum*) had slightly thicker threads, and the A4 series isolate (Pan 4) had nodular lumps on the threads.

Spores Most isolates in all of the groups have light brown (by transmitted light), 9-10 μ diameter, minutely warted spores. However, one isolate (CR 2) in the A1 mating series has 10.5 μ diameter spores with more prominent warts. Two isolates (Mex 1 and Mex 2) of the A5 mating series, one isolate (Ky 1) of the A2 mating series, and the nonheterothallic Mo 1 isolate have pale brown nearly smooth spores. Also, the nonheterothallic Fr 1 isolate has medium brown colored spores.

Stalk morphology The stalk length of the isolates varies from 0.4 to 1.0 mm, with the nonheterothallic SA 2 isolate an outlier at 0.24 mm. However, the stalk comprises a minimum of 60% of the total sporangial height in all isolates, with a range of 60-(70 average)-82%. Only the A0 mating series isolates, in which all isolates fall within a 60-65% range, display any group consistency. Stalk taper varies with length and correct development. Short stalks have little taper while long stalks have the most taper. However, slow or poor development also produces stalks with less than normal taper. The stalks of all isolates are striate (developmental shrinkage lines) and lack lime inclusions.

Stalk color This trait is used as a key characteristic for species identification in this cluster (Martin and Alexopoulos, 1969; Nannenga-Bremekamp, 1972). The major determinant of stalk color in all isolates is plasmodial color, with some modifications due to developmental difficulties and substrate pigments. Plasmodia fall

into five color classes: light yellow brown, light brown, medium yellow brown, strong brown, and vivid yellow. In incident light, light yellow brown plasmodia produce light yellow to light yellow brown colored stalks, light brown plasmodia produce light red brown to medium red brown (rare) colored stalks, medium yellow brown plasmodia produce medium red brown colored stalks, strong brown plasmodia produce light red brown (rare) to medium red brown to brownish black (rare) colored stalks, and vivid yellow plasmodia produce medium red brown to medium red stalks. The darker colors are usually produced during slow or poor sporangial development. The base of the stalk is often darker, especially on natural substrates, due to the uptake of dark substrate materials during development. The vivid yellow plasmodial color is found only in the A0 mating series (*D. ovoideum*) isolates and is apparently confined to this group. The rest of the plasmodial color types are all variants of a general brown type which contains both red and yellow pigments. The light brown and light yellow brown plasmodia contain lower concentrations of the red pigment (Collins and Clark, 1966; Collins and Erlebacher, 1969) and the medium yellow brown plasmodia probably (not tested) have higher levels of the yellow pigment. These brown plasmodia variations are controlled by several genes (Collins and Clark, 1966; Collins and Erlebacher, 1968) and thus within group variations occur in all mating series having a reasonable sample size. For example, stalks in the A1 series can vary from light yellow to blackish brown not only in the series but also within a single isolate.

Columella morphology and inheritance Columella formation in *Didymium* species results from the folding back of the sporangial head over the expanded stalk apex during development and the deposition of lime on the inside (columellar surface) and outside (columellar cavity) of the peridial membrane (Welden, 1955). Depending upon the extent and position of the fold back and the amount and location of lime deposition, a variety of columellar forms can be produced that vary from the wide shallow umbilicus found in *Didymium clavus* (Alb. & Schw.) Rab. to the stalked spheroid described for *D. nigripes* (Link) Fries.

A1 mating series columella Although the types of columella produced in this series (Fig. 1) are quite variable, they can be divided into two broadly delimited groups - either a closed umbilicus with a depressed-globose to discoid-shaped peridial columella (Hon 1, CR 2, CR 5, CR 8 and Gua 2) or an open umbilicus with a thick lime dome on the expanded stalk tip (Pan 2 and Pan 3). However, considerable variation occurs within each of these two groups. Isolates in the closed umbilicus group differ not only in the shape of the columella (a gradient from the flattened discoid of CR 8 to the depressed-globose form of CR 2), but also in terms of lime deposition (varying from the thick crust, especially on the stalk apex, of Hon 1 to the thin layer found in CR 5). Also, in some individual sporangia of the closed umbilicus group the folded peridium does not fuse with the stalk and thus would fit into Nannenga-Bremekamp's (1972) definition of a pseudocolumellar sporangium. The open umbilicus isolates also differ, with Pan 2 having an extremely shallow umbilicus, whereas Pan 3 has a considerably deeper structure (more extensive folding during development).

A2 and A5 mating series columella Even within the limited samples of these two mating series, considerable columellar variation exists (Fig. 2). The two A2 isolates differ in that Va 1 has a fairly open umbilicus while Ky 1 has a closed umbilicus that produces a stalked columella. The color of the columella in Ky 1 can also vary

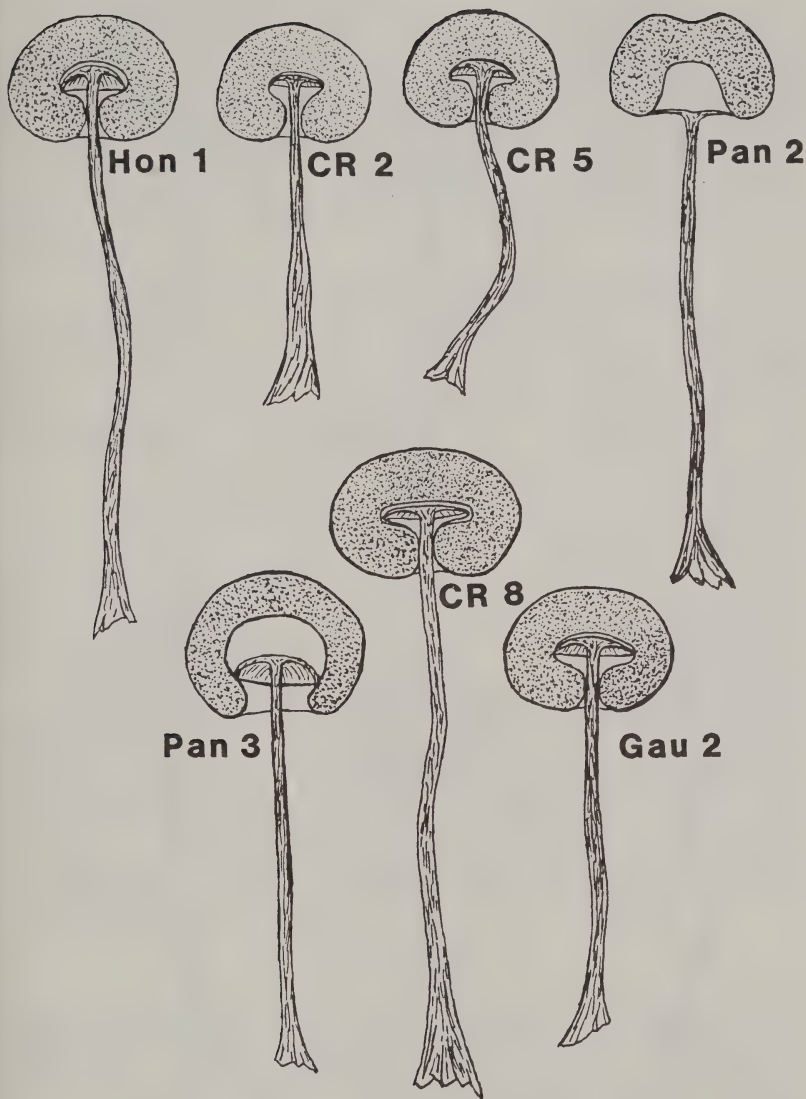


Fig. 1. Columellar morphology in cross section of representative sporangia of the A1 mating series. Isolates Hon 1, CR 2, CR 5, CR 8, and Gua 2 have closed umbilica and subglobose to discoid columellae with relatively thin lime crusts, whereas isolates Pan 2 and Pan 3 have open umbilica and thick domed lime columellae.

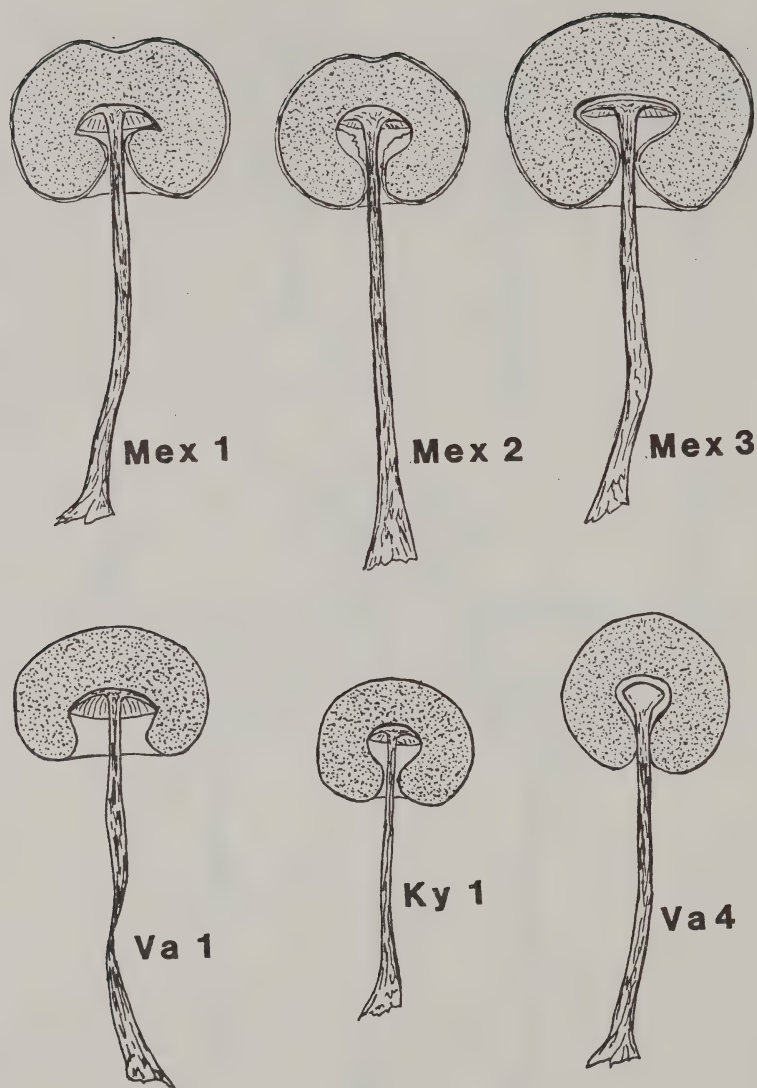


Fig. 2. Columellar morphology in cross section of representative sporangia of the A0, A2 and A5 mating series isolates. Isolate Va 5 is in the A0 series and has a closed umbilicus and a globose columella with a thick lime layer. Isolates Ky 1 and Va 1 are in the A2 series, and the Ky 1 isolate has a closed umbilicus and globose columella whereas the Va 1 isolate has an open umbilicus. Isolates Mex 1, Mex 2, and Mex 3 are in the A5 series and have closed umbilia and globose to discoide columellae.

from white to light brown, depending upon conditions during sporulation.

While all three of the isolates in the A4 mating series have a closed umbilicus, the columella that results can vary from discoid (Mex 1), to discoid/subglobose (Mex 3), to subglobose (Mex 2). The isolates also vary in terms of columellar lime, with Mex 1 having almost no lime, Mex 2 having a moderate lime crust, and Mex 3 being unique in having lime deposits within the hollow columellar region. The columella in all three isolates is generally white, but even apparently well formed sporangia can produce a light brown tinged columella. These variations occur within three isolates that presumably represent a single population from Quintana Roo, Mexico (Clark and Landolt, 1993).

A0 mating series This series corresponds to the *Didymium ovoideum* morphospecies in which all isolates have a closed umbilicus with a globose columella consisting of a stalk apex covered with a thick lime deposit (Fig. 2). Occasionally, a columella will have a yellowish tinge or appear spiny (lime covering the bases of the columellar threads). Since all of the isolates examined, to date, are from a relatively small area (southwestern Virginia and northern West Virginia), this species may display greater variations over its entire range.

Nonheterothallics The nonheterothallic isolates (Fig. 3) are a diverse group with some isolates indistinguishable from the closed (Ha 1, Jap 1) or open (Tx 2) umbilicate sexual isolates, whereas others such as Gua 1 and Mn 5, with their wide deep umbilicus, are somewhat different from any of the known sexual isolate. Finally, the Ca 8 and SA 2 isolates, with their small size, wide shallow umbilicus and medium-yellow-brown plasmodia, may be different enough to qualify them as taxa not related to any of the other isolates.

Columellar inheritance A cross of a Hon 1 (depressed-globose columella) clone with a CR 8 (discoid) clone produced hybrid sporangia with depressed-globose columella (Fig. 4). When single spore clones derived from these hybrids were backcrossed to the original two parental clones having the appropriate mating type, the resulting sporangial columella varied from globose to discoid (Fig. 4). However, the columella morphology of these sporangia did not indicate a simple Mendelian pattern of inheritance. Therefore, columella morphology is probably determined by both developmental factors (the HC-1 X H backcross varied considerably between different sporangia) and multigenic inheritance.

DISCUSSION

Molecular biological studies of myxomycete ribosomal DNA suggest that these protistan organisms had an ancient divergence from the rest of the eukaryote lines (Johansen et al., 1988). Also, *Didymium iridis* (Ditmar) Fries and *Physarum polycephalum* Schw., which have been placed in different families within the order Physariales, apparently separated from each other 400-500 million years ago (Johansen et al., 1992). This suggests that myxomycetes have a stable developmental system and that the species level taxa have had a very long period of time to produce the mix of geographically based sibling species and abundant nonheterothallic (presumably apomictic) lines that are found in morphospecies groups such as *D. iridis*. Long term isolation could produce sibling species that accumulate genetic differences and, therefore, the occasional rare hybrid between them (Clark and Stephenson, 1990) could lead to the selection of

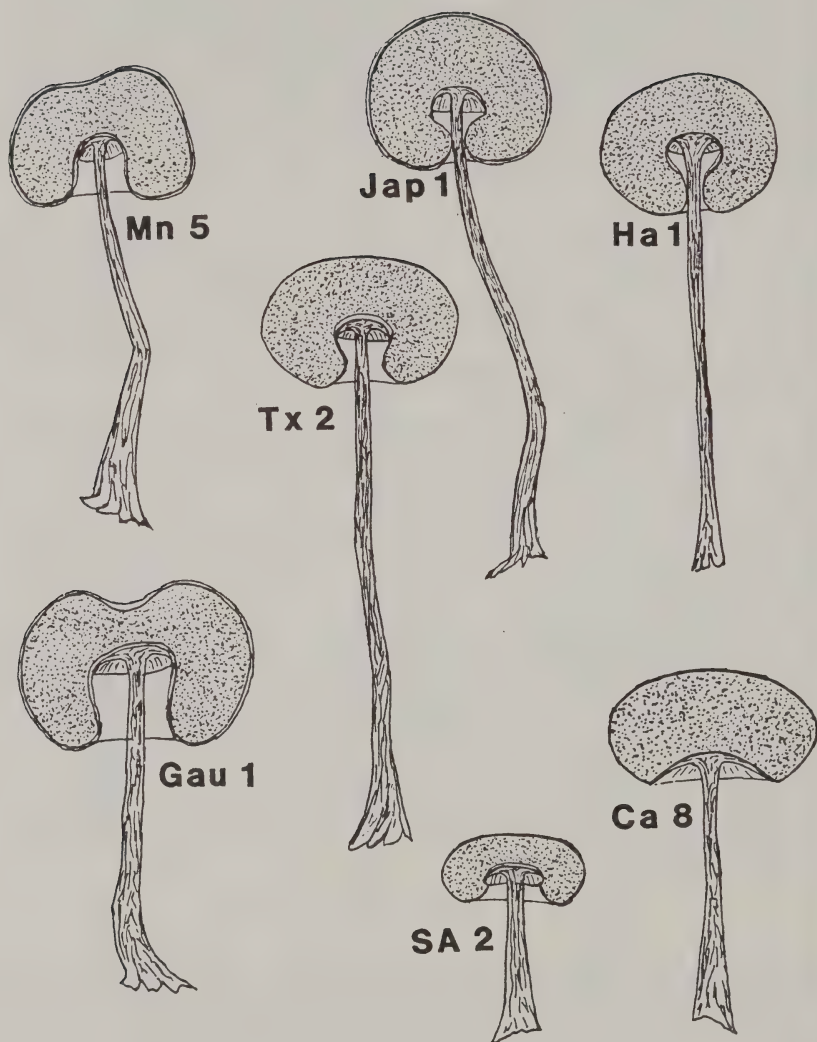


Fig. 3. Columellar morphology in cross section of representative sporangia from the nonheterothallic isolates. The morphology ranges from open shallow umbilica (Ca 8 and SA 2), to deep umbilica (Mn 5, Tx 2 and Gua 1), to closed umbilica and globose coulmeallae (Ha 1 and Jap 1).

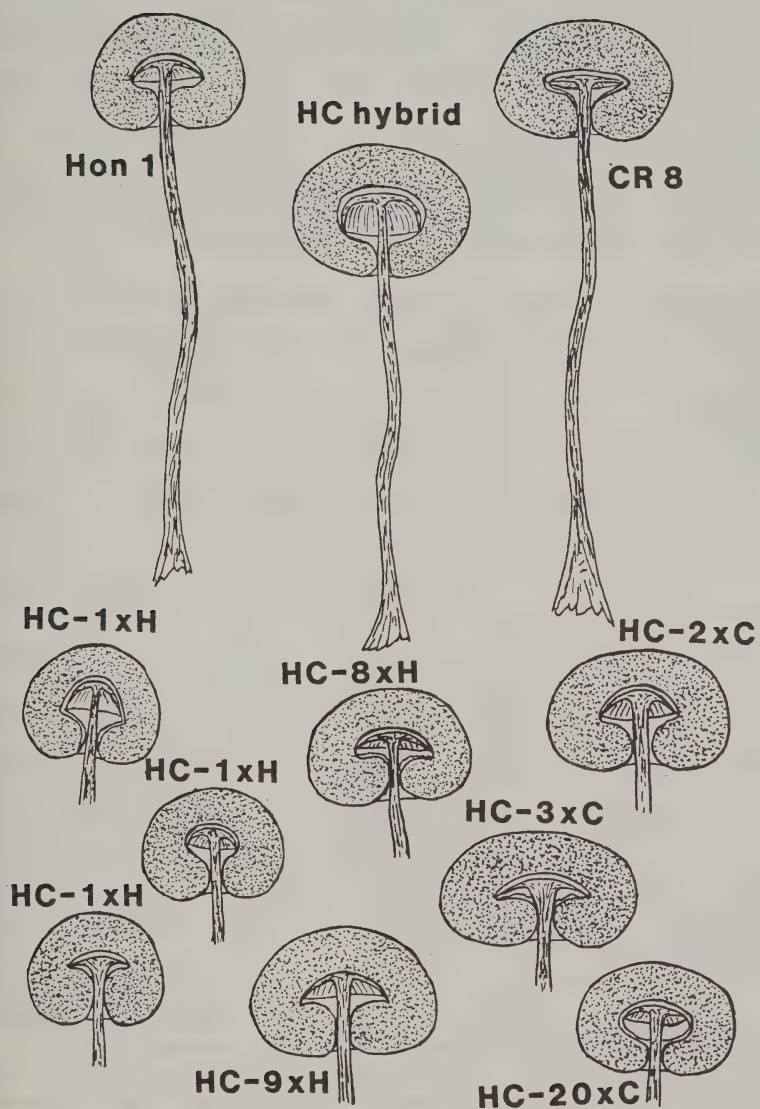


Fig. 4. Columellar morphology in cross section of representative sporangia showing columellar inheritance. Hon 1 and CR 8 are globose and discoid columellar parents, HC is the hybrid derived from crossing the two parents, and the HC- sporangia are progeny derived from backcrossing the hybrid back to the two parents. These backcross progeny show the range of inherited and developmental variations in columellar morphology.

apomictic lines due to genetic segregation difficulties. This mix of reproductive systems, combined with a suite of morphological variations that are available to all of the subgroups, could produce species complexes that are difficult to define taxonomically. While the sibling species are no doubt good taxa, there are to date no apparent morphological characteristics that can be used to reliably distinguish them from each other. Even the *Didymium ovoideum* morphospecies, which corresponds to the A0 mating series, overlaps morphologically with some isolates of the other groups. On the other hand, the nonheterothallic (apomictic) lines appear to be, for the most part, specialized local populations for which formal taxonomic designation are probably not called for even when they are somewhat morphologically distinct.

Morphospecies Martin and Alexopoulos (1969) considered *Didymium iridis*, *D. nigripes*, *D. ovoideum*, *D. megalosporum* Berk. & Curt., and *D. verrucosporum* Welden to be related species, and Nannenga-Bremekamp (1972) reinstated *D. proximum* Berk. & Curt. and *D. eximium* Peck from synonymy with *D. iridis* and *D. megalosporum*, respectively. Also, the non-calcareous long-stalked species *Didymium bahiense* Gottsberger, *D. lenticulare* Thind & Lakhanpal, *D. dictyopodium* Nann.-Brem. & Yamam., *D. columella-cavum* Hochg., Gottsb. & Nann.-Brem., and *D. eremophilum* Blackwell & Gilbertson were described after the Martin and Alexopoulos monograph was published. The validity and delimitations of these taxa will be discussed in terms of current studies on culture, mating systems, and morphology.

Didymium iridis As defined by Martin and Alexopoulos (1969) this taxon fits the majority of the closed umbilicate isolates and is, therefore, considered to be the core group of the non-calcareous long-stalked *Didymium iridis* species complex.

Didymium nigripes All published reports (Kerr, 1961; Clark and Collins, 1968) of cultured *D. nigripes* are now considered to have involved *D. iridis* isolates (Betterley and Collins, 1983). Sporangial collections identified as *D. nigripes* and which can be grown in culture (Ky 1 and Ind 1) produce typical *D. iridis* sporangia under most conditions. However, sporangia with dark stalks and columella can be produced by these, and other, *D. iridis* isolates under suboptimal sporulation conditions. Since most *D. nigripes* type sporangia collected from the field are non-viable, and the viable sporangia produce *D. iridis* type sporangia, it is most likely that the current *D. nigripes* description does not correspond to a distinct taxon. However, there remains the possibility that this morphospecies is a true taxon that can not be cultured with present techniques.

Didymium bahiense No reported cultures of this morphospecies exist, although a number of the isolates in this report closely match the species description. The presence of a pseudocolumella is the major defining character for this morphospecies (Gottsberger, 1968). However, since this is the same as an open umbilicus, it can not be used as a distinguishing character. This would leave the patches of larger warts on the spores as the defining feature of this taxon.

Didymium verrucosporum Cultures of this rarely seen morphospecies also have not been reported. The description of this taxon, with the exception of the nodding stalks and patches of large warts on the spores, is also very close to the *D. iridis* sporangial type. Since sporangial nodding can be induced in *Didymium* cultures by water stress (4% agar) during sporulation (Clark, unpublished), the patches of larger warts would again seem to be the major distinguishing character of this taxon.

Didymium lenticulare This is another rarely reported morphospecies that has not been cultured. Although *D. lenticulare* has some unusual characteristics such as its wide, flat umbilicus and somewhat stout capillitium (Thind and Lakhanpal, 1968), it approaches the outer limits of the *D. iridis* complex and may, therefore, be a local clonal variant.

Didymium dictyopodium This morphospecies, described from a single collection, differs from *D. lenticulare* in that it has more a delicate capillitium and fine reticulations on the stalk (Nannenga-Bremekamp and Yamamoto, 1986). The fine reticulations on the stalk would therefore be the distinguishing character for this taxon. This would appear to be a rather minor character, and thus this species also may be a rare local variant.

Didymium columella-cavum This interesting morphospecies is known from a single collection and there is some question as to its position in the non-calcareous stalk group since it is described as containing small amounts of obscure crystalline lime throughout the stalk. However, it is the hollow stalk apex (columella) that is the unique feature of this collection (Hochgesand et al., 1989). While none of our isolates has this character, we do occasionally see a similar structure in some of the globose columellar types (Hon 1, Ha 1), where the upper part of the stalk (from the umbilicus to the widened apex) is so poorly formed that a hollow region is produced.

Didymium megalosporum This is another commonly reported morphospecies that has not been cultured. While none of the isolates considered in this study completely fit the morphospecies description, one or more of the distinguishing characteristics can be found in a number of the isolates. The lobate shape (irregular shape associated with an upper umbilicus) can be found in the Pan 2, Mex 1, and Gua 1 isolates, which are all in different reproductive groups. *Didymium megalosporum* sporangia are described as pale yellowish brown to white, and while none of the isolates in this study were consistently yellowish brown, a number produce pale yellowish brown sporangia under suboptimal fruiting conditions. The discoid, somewhat open umbilicus columella (psuedocolumella) described for this morphospecies also can be found in both the A1 (CR 5, CR 8, and Gua 2) and A5 (Mex 1 and Mex 3) mating series. However, no isolates have the expected rugose to spiny columella, but this may not be a consistent characteristic, since the *D. ovoideum* isolates, which are also supposed to have a spiny columella, rarely display this character. The pale, nearly smooth spores described for this morphospecies also are found in the A5 mating series (Mex 1 and Mex 2) isolates. Since the A5 mating series seems to display many, but not all, of the characteristics of this taxon, it (and any related nonheterothallic lines) could have served as the basis for this morphospecies description.

Didymium eximium Although Nannenga-Bremekamp (1972) has revived this taxon from synonymy with *D. megalosporum*, it would, on the basis of her description, remain in our concept of *D. megalosporum*.

Didymium ovoideum Although the features of this taxon overlap with *D. iridis*, the correlation with the A0 mating series and the presence of several fairly unique morphological characteristics separates it from the other mating series. These characteristics are the slightly prolate (occasionally globose) sporangia, medium red brown to medium red colored stalks, and the globose (to prolate), calcareous columella.

Didymium proximum Nannenga-Bremekamp (1972) has revived this morphospecies on the basis of the presence of a clavate columella. However, since a

clavate columella could be considered as an extreme variant of a prolate columella and the stalks are described as rufous colored, this taxon is included in our concept of *D. ovoideum*.

Didymium eremophilum While technically a long-stalked *Didymium*, this minute species is apparently adapted to the desert environment (Blackwell and Gilbertson, 1980) and displays few characteristics that would tie it to the other long stalked species.

Other stalked species This study has been concerned with the non-calcareous, long-stalked *Didymium* species. However, since these obvious and useful morphological features may be rather arbitrary taxonomic characters, future work should be extended to both the calcareous and short-stalked morphospecies.

Conclusions Excluding *Didymium eremophilum*, a minute desert species, the non-calcareous long-stalked *Didymium* isolates can be placed into three species complexes that in general, correspond to modified Martin and Alexopoulos (1968) descriptions of *D. iridis*, *D. ovoideum*, and *D. megalosporum*.

***Didymium iridis* complex** This complex would include the *Didymium bahiense*, *D. iridis* and *D. nigripes* morphospecies as common forms of a large and rather variable group composed of a number of regional sibling species (mating groups A1, A2, A3, A4, A6, and A7) and numerous nonheterothallic (presumably apomictic) lines. The rarer morphospecies such as *Didymium verrucosporum* (and possibly *D. columella-cavum*, *D. dictyopodium* and *D. lenticulare*) are considered, pending culture studies, to be local apomictic lines displaying some of the morphological extremes of this complex.

This is a large and variable complex that is difficult to circumscribe since it includes most of the variations found in the non-calcareous long-stalked *Didymium* group. The sporangia are depressed-globose to rarely globose, umbilicate, and have a colorless to light brown-tinged membranous peridium covered with white stellate (often amorphous in culture) lime crystals. The sporangia contain delicate, light brown to colorless, branching and anastomosing capillitia and light brown (rarely medium brown) minutely warted (rarely medium warted), 9-10 μ diameter spores. The tapered to straight stalk comprises 60 to 80% of the total sporangial height and is generally medium red brown in color. However, stalk color is mainly determined by the genetically variable plasmodia color and therefore ranges from light yellow to brownish black in this complex. The columella also is extremely variable in this complex and ranges from a flat open umbilicus with a thickened stalk apex to a stalked globose "true" columella. Within the columella, the stalk apex region is covered with white (rarely light brown) lime, which varies from a thin crust to a thick dome-shaped structure.

While the regional sibling species could be validated as distinct taxa, the inability to morphologically distinguish between these groups themselves and also the nonheterothallic lines makes this a difficult procedure to justify. Also, rare somewhat morphologically distinct collections, which are likely to be local nonheterothallic (apomictic) lines, probably should not be recognized as separate species.

***Didymium megalosporum* complex** This complex is based on a number of isolates that have a combination of traits found in the *D. megalosporum* morphospecies description. While none of the isolates display all of these traits, and the characters are often difficult to distinguish from the *D. iridis* complex, there still seems to be a basis

for considering this group of isolates as a separate complex. The A5 mating series is sympatric to several of the *D. iridis* complex mating series and contains isolates with many *D. megalosporum* characteristics. These isolates have a robust globose to discoid sporangium that can often appear lobate due to an upper umbilicus. They also have a generally globose columella, which is frequently tinged light brown, and most also have nearly smooth spores. However, the distinctive ochraceous sporangial color and rugose columella of the *D. megalosporum* description were not found in this cultured material. Therefore, the *Didymium megalosporum* morphospecies is probably based, in part, on the morphological extremes of this sibling species (mating series A5) and, in part, on globose to subglobose *D. ovoideum* isolates. Although this complex blends into the *D. iridis* and *D. ovoideum* complexes, the sympatric distribution of the mating series and the slight morphological differences are probably enough to maintain this group as a separate taxon. The *Didymium eximium* morphospecies, as defined by Nanenga-Bremekamp (1972), also would be included in this complex.

***Didymium ovoideum* complex** The A0 mating series, which is sympatric to a *D. iridis* complex mating series, the prolate sporangia and the medium red to medium red brown stalks provide the distinctive characters for this complex. The vivid yellow plasmodium, which produces the stalk color, is also quite different from the light yellow to strong brown plasmodia of the other two complexes. The *Didymium proximum* morphospecies also would be included in this complex.

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A NEW FOLIICOLOUS BYSSOLOMA (LICHENIZED ASCOMYCETES: PILOCARPACEAE) FROM THE ATLANTIC RAINFOREST IN PERNAMBUCO, BRAZIL

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Summary: In the course of a floristic survey of foliicolous lichens in the Atlantic rainforest (Mata Atlântica) of Pernambuco State, Brazil, a new species of *Byssoloma* was discovered. *B. pernambucensis* Cáceres sp.n. is characterized by its compact margin encrusted with colourless crystals, its orange to reddish brown apothecial discs, and its pale bluish grey thallus. Thus far, the new species is only known from a single rich collection at the type locality.

Introduction

The Atlantic rainforest, or Mata Atlântica, is an evergreen forest with distinct dry season which extends along the Atlantic coast of Brazil from the states of Paraíba and Pernambuco to Rio de Janeiro and São Paulo. It is geographically isolated from the Amazon rainforest by the Brazilian Shield, a plateau covered with dry shrub and savanna vegetation (MORAWETZ 1993). Due to extensive deforestation and land use change, less than 5 % of the original primary forest of the Mata Atlântica are left today (WHITMORE 1990). The remaining forest fragments still shelter a comparatively rich foliicolous lichen flora, taking into account the distinct dry season which eventually reduces foliicolous lichen diversity as compared to constantly humid rainforests (SÉRUSIAUX & DE SLOOVER 1986; LÜCKING 1995). A revision of the foliicolous lichens collected by the Brazilian mycologist A. C. Batista (LÜCKING et al. 1998, 1999), together with a recent survey based on collections from various localities, revealed about 210 taxa, including a number of lichenicolous fungi (CÁ CERES et al. 1998). During this work, several new species were detected which are partly described elsewhere (CÁ CERES & LÜCKING 1999; LÜCKING & CÁ CERES 1999). The present paper introduces a further new species assigned to the genus *Byssoloma*.

Byssoloma pernambucensis Cáceres sp.n.

Figs 1, 2

A. Byssoloma confuso apotheciis aurantiacis vel rubro-fuscis differt.

Typus: BRAZIL, Pernambuco: São Lourenço da Mata, Estação Ecológica de Tapacurá, 8° 02' S, 35° 09' W, 100 m, remnants of the Mata Atlântica, on leaves, Ill. 1998, Cáceres & Lücking 98-315 (URM: holotypus; hb. Cáceres, hb. Lücking: isotypi, also to be distributed in Lücking: Lichenes Foliicoli Exsiccati).

Thallus epiphyllous, crustose, continuous, minutely farinose, pale greenish grey with a bluish tinge, up to 10 mm in diam. Phycobiont a species of *Trebouxia* s.lat., cells 4-7 µm in diam. Apothecia sessile, basally constricted, 0.2-0.3 mm in diam., 0.1-0.12 mm high; disc orange to reddish brown, flat; margin distinct, compact, white to pale yellowish white, slightly prominent. Exciple well developed but very compact, densely encrusted with colourless crystals which dissolve in KOH; its internal part ± paraplectenchymatous, 5-15 µm thick, byssoid hyphae with cylindrical cells reduced to the external parts, 15-20 µm thick. Epithecium indistinct, granular. Hypothecium orange-brown, 20-35 µm high. Hymenium colourless, 45-50 µm high. Paraphyses branched and anastomosing, 0.7-1.0 µm thick. Asci of the *Byssoloma* type, with a distinct, l+ light blue tholus and darker tubular structure, clavate, 40-45 x 8-10 µm. Ascospores 8 per ascus, colourless, ellipsoid, 3-septate, 12-15 x 3.0-3.5 µm. Pycnidia wart-shaped, prominent, 0.15-0.2 mm diam., covered by algiferous thallus tissue encrusted with crystals, whitish, ostiole wide open. Conidia numerous, simple, pear-shaped, 4-7 µm long and 0.8-1.0 µm (proximal end) to 1.5-1.7 (distal end) µm broad.

Notes: *Byssoloma pernambucensis* is characterized by a compact apothecial margin encrusted with crystals. Still, the typical byssoid hyphae with cylindrical (not inflated!) cells are observed in the outer parts of the exciple after dissolving the crystals with KOH. This feature is shared with several other species of the genus, i.e. *B. amazonicum* Kalb & Vězda, *B. anomalum* Kalb & Vězda, *B. confusum* Farkas & Vězda, *B. dimerelloides* Sipman & Aptroot [= *B. clauzadei* Kalb & Vězda], *B. subundulatum* (Stirt.) Vězda, and *B. syzygii* Vězda & Vivant (SANTESSON 1952; VĚZDA 1994; KALB & VĚZDA 1990; APTROOT & SIPMAN 1991; FARKAS & VĚZDA 1993). *B. syzygii* differs from the other species of this group by its 5-7-septate ascospores, while *B. amazonicum* is characterized by a verrucose, greenish thallus and yellowish crystals in the exciple. In *B. subundulatum*, the light brown apothecia are growing marginally hypophyllous. *B. confusum*, *B. dimerelloides* and *B. pernambucensis* are rather similar in their external aspect and differ mainly in the colour of the apothecial disc, which is blackish brown in *B. confusum*, pale yellow to orange in *B. dimerelloides* and orange to reddish brown in *B. pernambucensis*. Furthermore, the thallus of *B. confusum* and *B. dimerelloides* is thinner, ± smooth and dispersed, and *B. dimerelloides* has a thinner apothecial margin (Table 1).

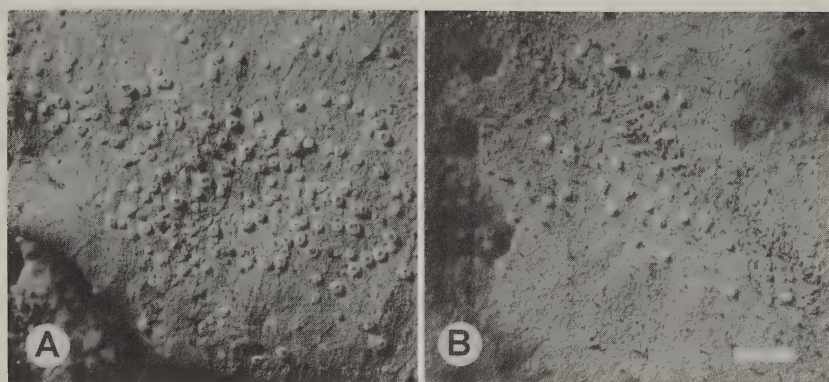


Fig. 1. *Byssoloma pernambucensis*, habit. (A) Apothecia, (B) pycnidia. Scale = 1 mm.

The seven species discussed above show very differentiated distribution patterns. *Byssoloma amazonicum*, *B. anomalum*, *B. syzygii* and *B. pernambucensis* are locally or regionally restricted to various parts of the Neotropics, while the others are paleotropical: *B. subundulatum* is known from Australia and New Zealand, *B. confusum* from Africa and New Caledonia, and *B. annua* from various localities in Australasia (Table 1).

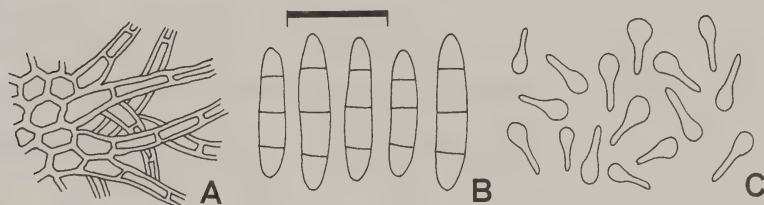


Fig. 2. *Byssoloma pernambucensis*, anatomy. (A) Lateral exciple, (B) ascospores, (C) conidia. Scale = 10 µm.

The species discussed above can also be confused with members of the genera *Badimia* and *Fellhanera* and some species currently placed in *Bacidia* and *Byssoloma* s.lat., for example *Fellhanera stanhopeae* (Müll. Arg.) Lücking, Lumbsch & Elix, *F. sublecanorina* (Nyl.) Vězda, *F. pilomarginata* Lücking, *Bacidia micrommata* (Kremp.) R. Sant., *B. psychotriae* (Müll. Arg.) Zahlbr., *B. submicrommata* Vězda, *Byssoloma ortizii* Lücking, and *B. wetsteinii* (Zahlbr.) Zahlbr. They can be distinguished mainly by the structure of the excipular hyphae: cylindrical cells in *Byssoloma* s.str. vs. inflated, angular-rounded cells in *Badimia*, *Fellhanera*, *Bacidia* s.lat. and *Byssoloma* s.lat. *Byssoloma pernambucensis* is particularly reminiscent of *Fellhanera sublecanorina* but, apart from the excipular structure, it can be distinguished by the orange to reddish brown vs. blackish brown apothecial discs.

Table 1. Distinction of species of *Byssoloma* s.str. with compact, crystalline exciple.

Species	Thallus colour	Verruciae	Apothecia	Excipular crystals	Spore septa	Distribution
<i>B. amazonicum</i>	greenish	+	dark brown	yellow	3	America (Amaz.)
<i>B. anomalum</i>	bluish	—	brown (pruin.)	yellow	3	America (Amaz.)
<i>B. confusum</i>	bluish	—	dark brown	white	3	Africa, Australia
<i>B. dimerelloides</i>	bluish	—	yellow	white	3	Australasia
<i>B. pernambucensis</i>	bluish	—	orange	white	3	America (Pern.)
<i>B. subundulatum</i>	bluish	—	brown	white	3	Australia (New Z.)
<i>B. syzygii</i>	greenish	—	brown	white	5-7	America (Guad.)

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LEPIDODERMA CRUSTACEUM, A NIVICOLOUS MYXOMYCETE, FOUND ON THE ISLAND OF CRETE

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ABSTRACT

The rare myxomycete *Lepidoderma crustaceum* Kowalski, recorded from only a few localities in the world, was found in a nivicolous situation in the White Mountains (Lefka Ori) in western Crete. The specimen is described, and scanning electron photographs are presented. Characters for differentiation between this species and the closely related *L. aggregatum* Kowalski are given. Although difficult to estimate due to the usually large annual fluctuations in abundance of nivicolous myxomycetes, devastation of the plant cover by overgrazing as well as a tendency towards lower winter rainfalls may deteriorate their growth conditions at the island of Crete.

KEYWORDS

nivicolous myxomycetes, *Lepidoderma crustaceum*, description, ultrastructure

INTRODUCTION

The nivicolous myxomycetes are an ecologically defined group, restricted to higher mountains, where on open places near melting snow banks plant refuse provides the substrate for their growth and development. They are well known from the western and central Alps (Meyer et al. 1992, Schinner 1981, Gottsberger 1966). The only investigated region which is climatically comparable to the Mediterranean zone are the mountains of California, where nivicolous myxomycetes were recorded by Kowalski. Several species new to science, including *Lepidoderma crustaceum*, resulted from his collecting activities. With this paper, which gives a comprehensive description of this rare species, including SEM-photographs, we wish to direct attention towards more intensive studies of nivicolous myxomycetes in the Mediterranean region.

MATERIALS AND METHODS

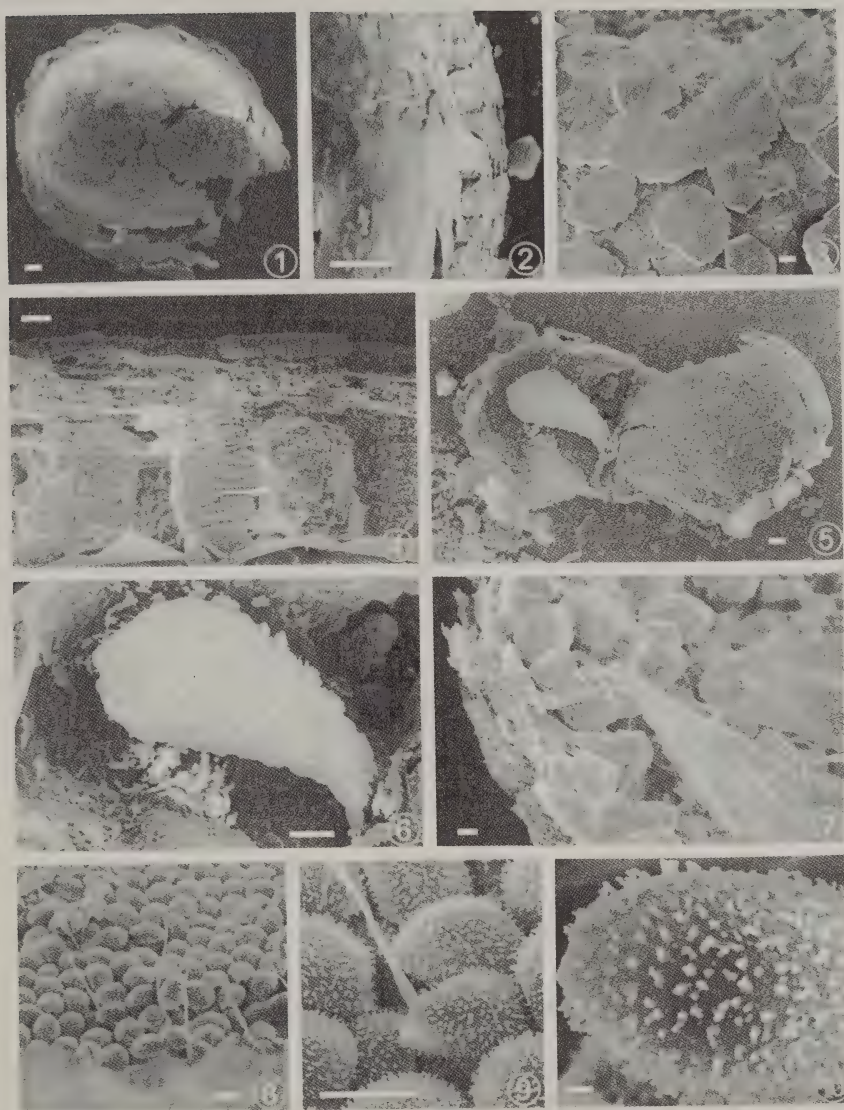
The field work described herein was carried out during a fortnight stay on Crete, ranging from mid-April to beginning of May 1994. Surveyed were the White Mountains in the surroundings of Hora Sfakion in western Crete as well as the Psiloritis (Ida) mountains north of Anoghia in the central part of the island, with both regions visited for 3-5 days. Sporocarps were preserved as permanent slides in polyvinyl lactophenol and/or glycerol gelatin, to distinguish between limeless and lime-containing structures. Air-dried sporocarps were studied with a JEOL 35c scanning electron microscope at St. Petersburg; mounted on copper stubs using a double-side sticky film and sputter-coated with gold up to 200-500 Å thickness. Morphological terms used for descriptions of sporocarps are those proposed by Dörfelt & Marx (1990). Vascular plant names are cited after Jahn & Schönfelder (1995).

RESULTS AND DISCUSSION

Lepidoderma crustaceum was found on April 25 in two colonies about 50 cm apart, both comprising several hundreds of large, spherical sporocarps. The locality was a stony, weakly north-exposed slope of the White Mountains (Lefka Ori) with a sparse garrigue of spiny shrubs, ca. 5 km north of the village Anopoli, 1550 ± 50 above sea level ($24^{\circ}05'20''$ E $35^{\circ}16'10''$ N ± 500 m). The fructifications occurred in dense, but not heaped clusters at approximately 20 cm height on living branches of *Berberis cretica* in the shadow of a boulder on the margin of a snow field more than 10 m in size and still up to 0.5 m thick.

The sporocarps are pale coffee brown, with a dense lime crust, globose to subglobose and sessile on a constricted base, having a diameter between 1.3 and 1.6 mm. Fig. 1 shows the outer peridium layer, a lime shell consisting of scales densely baked together. Sometimes this lime crust disappears, revealing the smooth true peridium (Fig. 2). The lime shell consists of pale brown scales, which appear plate-like and confluent on the surface (Fig. 3) but are separated clearly from each other in deeper sections (Fig. 4). It cannot be ruled out that this may be a result of weathering during rainfalls, with subsequent recrystallisation in the upper part. The true peridium is a thin, translucent and iridescent membrane, firmly attached to the lime shell but often separating if the outer layer is broken (Fig. 4). All sporocarps had a large, clavate columella consisting of pale, amorphous lime, reaching at least one half of sporocarp diameter (Fig. 5). The capillitium consists of flexuous, violet-brown to translucent threads 1-1.5 µm in diameter, which sometimes branch or form vesicular enlargements (Fig. 8, 9). Arising from the columella, especially from the upper end (Fig. 6), capillitial threads are connected also with the peridium (Fig. 7). The spore mass is dark violet-brown to black, the spores are 13-14(-14.5) µm in diameter and ornamented with somewhat irregularly distributed spines up to 0.5 µm long (Fig. 10), sometimes one side of the spores appears paler than the rest.

The double peridium, the constricted base and the pale, light brown lime shell leads to *L. crustaceum* Kowalski (1967), although a few characters differ from his diagnosis: our specimen has slightly larger spores (given as 11-13 µm by Kowalski 1971), larger sporocarps (size



Figs. 1-10 SEM-photographs of *Lepidoderma crustaceum* (Schnittler 3551, in herbarium JE). 1 Whole sporocarp. 2 Lime shell and peridium; bars = 100 μ m. 3 Lime crystals seen from above. 4 Lime crystals, side view with the peridium on bottom; bars = 10 μ m. 5, 6 Columella; bars = 100 μ m. 7 Peridium with attached capillitial threads. 8, 9 Spores with capillitium; bars = 10 μ m. 10 Spore ornamentation, bar = 1 μ m. Photos Y. Novozhilov.

given as 1-1.5 mm), and a more pronounced, almost clavate columella (described as conical, occasionally spherical). The most closely related species is the similar rare *L. aggregatum* Kowalski (1971). Tab. 1 shows separating characters based on our SEM-observations of *L. crustaceum* in comparison with *L. aggregatum* (Novozhilov & Schnittler 1997), considering the original descriptions of Kowalski (1967, 1971).

At present, *Lepidoderma crustaceum* is known from only a few localities throughout the world, all in nivicolous situations: Casseron, Switzerland (leg. Meylan); Butte Co., California, USA; Mt. Rainier, Washington, USA (see Kowalski 1971), and the Italian Alps (Credaro & Pirola 1986).

Tab. 1 Separating characters between *Lepidoderma aggregatum* and *L. crustaceum*.

character	<i>L. crustaceum</i>	<i>L. aggregatum</i>
sporocarp diameter	(1-) 1.2-1.5 (-1.7) mm	(1.5-) 1.6-2 (-3) mm
sessile on a	constricted base	broad base
spore mass	violaceous brown	purple brown
spore diameter	(11-) 12-14 (-14.5) μ m	(11-) 13-15 μ m
spore ornamentation	long spines up to 1 μ m	short, blunt spines up to 0.7 μ m
spore appearance	one side paler	uniformly coloured
lime shell	pale coffee brown, forming a dense crust which sometimes separates from the peridium	white to cream, less dense, firmly attached to the peridium
columella	conical to clavate	spherical
capillitium	sparse, 1-1.5 μ m in diameter	abundant, 0.5-1 μ m in diameter

On the island of Crete, in spite of intensive search during several day excursions leading up to 2000 m, nivicolous myxomycetes were encountered only in a single location. This shallow, slightly north-exposed slope is probably situated above the natural timberline dropping down to 1500 m on north-exposed slopes. With light night frost in depressions but sunny, warm days having noon air temperatures around 20 °C, large snow fields melt quickly, keeping a belt of several meters of soil wet. These conditions should be favourable for nivicolous myxomycetes (Schinner 1981, Novozhilov & Schnittler 1997). But, the total vegetation cover was lower than five percent, consisting of small clusters of the endemic *Berberis cretica*, *Euphorbia acanthothamnos* (= *E. spinosa* L.) and *Astragalus creticus*, more rarely *A. angustifolius*, all forming very dense, spiny and cushion-like shrubs less than 50 cm high. The habitat can be classified as subalpine dwarf-shrub heathland. Remarkable was the almost complete absence of non-spiny, herbaceous plants except geophytic species such as *Crocus sieberi*, *Scilla nana* or *Muscari spreizenhoferi*, all in full bloom during this time. The only larger herbaceous plant was the endemic *Anchusa cespitosa*, growing in flat, patchy dwarf tussocks. *Lepidoderma crustaceum* was found together with *Diderma alpinum* Meylan, which formed one fructification nearby. In both cases, thorny branches of *Berberis cretica* emerging from the snowfield formed the substratum.

One limiting factor for the abundance of nivicolous myxomycetes are winter snow falls. In spring, the melting snow banks deliver water to keep the substrata, all kinds of plant refuse, wet. Only a high snow cover lasts until sunny days with higher day temperatures provide suitable growth conditions. Thus, abundance in nivicolous myxomycetes can highly fluctuate from year to year with snow cover and spring weather conditions. With this paper as the first published record for a nivicolous myxomycete on Crete, it is almost impossible to judge if the few myxomycetes seen in 1994 were the remnants of a formerly richer flora or represent the natural occurring species diversity.

But, from our observations and literature studies it became obvious that within the last decades two factors acted almost certainly against nivicolous myxomycetes. The first factor is devastation of the plant cover. Undisturbed subalpine dwarf-shrub heathlands would bear a rich flora of annual herbs and especially grasses, reaching proportions between 25 and 50 per cent on the total plant cover (Hager 1985: 102). The reason for the absence of herbs became obvious in the villages: large flocks of sheep and goat, which will be later in the year brought to the mountains, there roaming free over the summer. According to a comprehensive description of the natural conditions and changes in sheep farming (Hempel 1995) as well as own observations, overgrazing and subsequent devastation of vegetation dramatically increased during the last decades:

- grazing focuses traditionally on the montane regions, (61 % of the region [nomos] Chania are pastures, and from these 71 % are in montane regions), but from 1936 to 1986, livestock in the region has almost doubled (Hempel 1995),
- the mixture of sheep and goat in a relation of roughly 2:1 is very aggressive for the vegetation, especially due to the ability of goats to consume woody and even spiny plant parts (Hager 1985: 98),
- due to their climbing abilities, goats become frequently naturalised, staying around the year in the mountains,
- in former times, the herds left the montane regions on the end of the summer, when the pastures were exhausted. Nowadays, with the availability of roads and vehicles, shepherds bring additional food like corn or potato foliage; the flocks stay in the mountains until winter begins, leading to a complete devastation of the vegetation (Hempel 1995).

This devastation effects were very impressive in the second of the three mountain areas on Crete, the Ida (Psiloritis) mountains around Anoghia. Large parts of the mountains exhibited only naked rocks, the devastation of the vegetation was nearly complete. Here, no myxomycetes were found in spite of the presence of large snowfields. In this area, the density of grazing sheep and goats is still higher (3.2 animals per hectare compared with 1.2 in the White Mountains, Hempel 1995). It is obvious that the density of the herbaceous vegetation and their previous-year remnants which form the substrata for myxomycetes must have dramatically decreased.

The second factor acts both directly and indirectly: from observations between 1947 to 1987 there is a tendency that winter rains come later and stop earlier, providing only 80-90 % of the former amount (Jacobeit 1994). This affects the ability of the vegetation to recover, but lowers also the winter snow cover. Thinner snow banks can disappear already in early spring during still cold but rainy days, before soil temperatures may be high enough to support the growth of nivicolous myxomycetes.

Only long-term studies and comparative investigations between disturbed and undisturbed areas can show in which extent both factors really threat nivicolous myxomycetes in the mountains of Crete. But, it cannot be ruled out that we have seen only remnants of a formerly richer and more widespread flora of snowbank myxomycetes in the mountains of Crete.

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FUNGI FROM PALMS. XLI. FASCIATISPORA SABALICOLA: FURTHER COLLECTIONS FROM FLORIDA, USA

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Abstract

During research on the genus *Anthostomella*, we found two further collections of *Fasciatispora sabalicola*, which is so far known only from the type, on petioles of *Sabal palmetto* collected in Florida, USA. This collections are reported and illustrated here.

Key Words: *Fasciatispora*, *Sabal*, USA, Xylariaceae.

Introduction

In the course of a monographic study on *Anthostomella* and related genera, two specimens of *Fasciatispora sabalicola* were found: one specimen was identified as *Anthostomella clypeata* (De Not.) Sacc. and an other specimen recorded as *Anthostoma sabalicolum* (an unpublished name), both of which were collected from *Sabal palmetto* in Florida, USA. The ascomata in

Fasciatispora sabalicola are immersed and asci are cylindrical and unitunicate, with a J+, wedge-shaped, subapical ring. The ascospores are brown and unicellular with a equatorial pallid band, with verrucose wall ornamentation and a sheath. The collections and illustration of *Fasciatispora sabalicola* are given below.

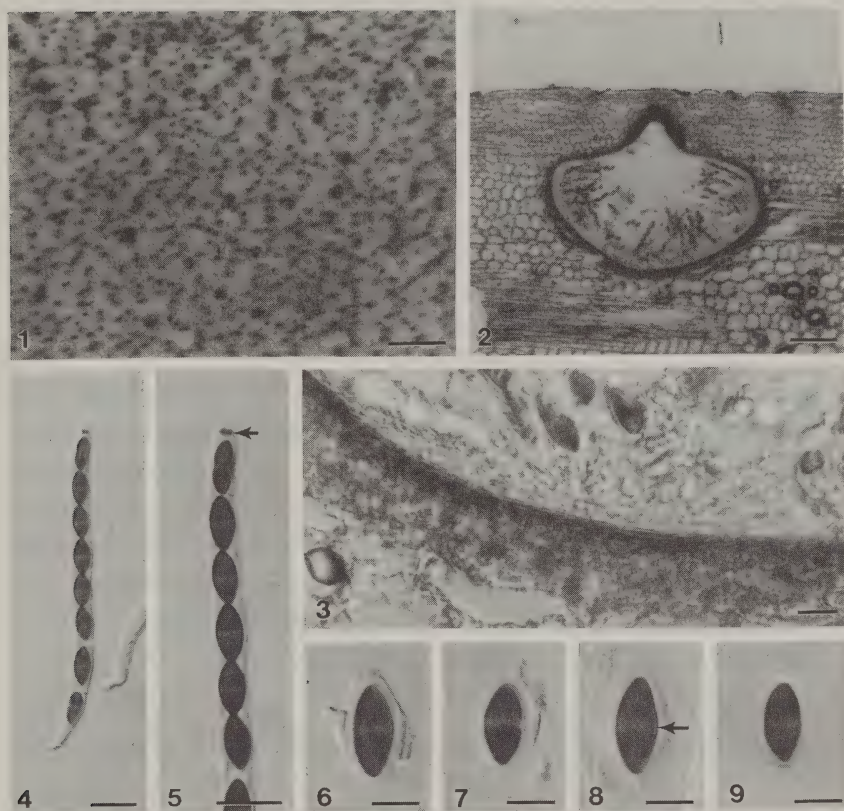
Material and methods

Specimens were loaned from W. Examination was carried out on material rehydrated in water. Slides of ascospores, asci and sections of ascomata were mounted in distilled water for observation, microphotography and measurement. Ascal apical rings were stained using Melzer's solution. Sections of ascomata were made on a Cryotome and mounted with O. C. T. compound.

Results and discussion

Fasciatispora sabalicola K. D. Hyde, *Nova Hedwigia* 61: 264 (1995). Figs 1-9

Ascomata immersed, visible as black dots on the host, solitary (Fig. 1); in vertical section ca 500 μm diam., 420 μm high, subglobose, brown, coriaceous, with a central, periphysate ostiolar canal, ca 40 μm diam., 100 μm high (Fig. 2). Peridium ca 17.5 μm wide, comprising several layers of compressed cells, wall hyaline at the inside, and brown and thick-walled towards the outside, where they are mixed with the host cells (Fig. 3). Paraphyses 4-5 μm ($\bar{x}$ = 4.3 μm), hypha-like, filamentous, flexuose, septate, unbranched, numerous and embedded in a gelatinous matrix. Asci 162.5-187.5 x 11.5-12.5 μm ($\bar{x}$ = 175.8 x 12.1 μm , n = 20), 8-spored, cylindrical, unitunicate, short-



Figs 1-9. *Fasciatispora sabalicola* (from holotype). 1. Appearance of ascomata on the host surface. 2. Section of ascoma. 3. Peridium with compressed cells, wall hyaline at the inside, and brown and thick-walled towards the outside, mixed with the host cells at the outside. 4, 5. Asci. Note J+, wedge-shaped subapical ring (arrowed in fig. 5). 6-9. Ascospores. Note a central pallid region (arrowed in fig. 8). Scale Bars: 1 = 500 μm ; 2-9 = 10 μm .

pedicellate, apically rounded, with a J+, wedge-shaped subapical ring, 5-5.5 μm ($\bar{x}$ = 5.2 μm , n = 10) diam., 2.5-3 μm ($\bar{x}$ = 2.5 μm , n = 10) high (Figs 4, 5). Ascospores 17.5-25 x 7.5-9.5 μm ($\bar{x}$ = 20.9 x 8.4 μm , n = 25), uniseriate, ellipsoidal, brown, unicellular, with a central pallid region and surrounded by a 2-

2.5 μm ($\bar{x}$ = 2.2 μm , n = 10) wide mucilaginous sheath, lacking germ slit or germ pores, wall distinctly verrucose (Figs 6-9).

Host: *Sabal*.

Known distribution: USA.

Material examined: USA, Florida, Kanto Park, on *Sabal palmetto*, Dec. 1941, C. L. Shear (W 12141, holotype); USA, Florida, Winter Park, on *Sabal palmetto*, 12 Dec. 1941, C. L. Shear (W 18893, as *Anthostomella clypeata*); USA, Florida, Old Faithful Spa, on *Sabal palmetto*, 14 Dec. 1945 (W 17245, as *Anthostoma sabalicolum*, an unpublished name).

Fasciatispora K. D. Hyde was introduced by Hyde (1991) as a monotypic genus in the Amphisphaeriaceae with *Fasciatispora nypae* K. D. Hyde as the type species. *Fasciatispora nypae* occurs on decaying intertidal rachides of *Nypa fruticans* in Brunei (Hyde, 1991). The genus was characterized by immersed ascomata, cylindrical unitunicate asci with an amyloid (J+) subapical ring, and unicellular brown ascospores with a wide equatorial pallid band. Alias *et al.* (1994) added a new species, *Fasciatispora lignicola* Alias, E. B. G. Jones & Kuthubutheen, from intertidal *Rhizophora apiculata* in Malaysia. Hyde (1995) described a further five *Fasciatispora* species, of which two were new species and three were new combinations. Based on analysis of rDNA and morphological studies, Kang *et al.* (1999) placed *Fasciatispora* in the Xylariaceae. The role of the central pallid band on the ascospores has been discussed by Hyde & Wong (1999).

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BUELLIA AERUGINOSA, A NEW AUSTRALIAN SPECIES WITH PLURISEPTATE SPORES

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Abstract. The new lichen species *Buellia aeruginosa* is described from New South Wales, Australia, where it occurs on coastal rocks. Superficially it resembles *B. alboatra* but is distinguished by spore characters and secondary chemistry.

Keywords: *Buellia*, *Diplotomma*, Physciaceae, flora of Australia, xanthonenes.

Introduction

According to published lichen checklists Australia seems to be poor in *Buellia* DeNot. species (Physciaceae) with pluriseptate spores, some of which are often referred to the genus *Diplotomma* Flotow. Only *B. alboatra* (Hoffm.) Th. Fr. (*Diplotomma alboastrum*) and *B. lauricassiae* (Fée) Müll. Arg. have so far been recorded (Filson 1988, 1996; Kantvilas 1994; McCarthy 1991; Sammy 1989). However, some of these records are based on misidentifications.

As part of a world-wide revision of the *Buellia* species with pluriseptate spores by the first author, Australian material collected by the second author was investigated. Among several *Buellia* species with 1-septate spores, two collections of an undescribed pluriseptate species were found, both from the same locality. Material was sent to the third author for a closer analysis of the secondary chemistry. This new species is currently placed in *Buellia* pending further studies of the phylogenetic relationships in this heterogeneous group.

Material and methods

Specimens from the type locality, deposited in CANB and UPS, were studied.

Spore measurements were made in water at 1000x magnification. Only well-developed spores with clearly visible septation lying outside the asci were measured. Measurements of spore size as well as other details represent extreme values.

Sections of apothecia were studied under the TEM. Before fixation the apothecia were softened in 10 % ammonia and washed with water. Fixation was made in 2.5% glutaraldehyde with a sodium cacodylate buffer at pH 7.2 for several days. The apothecia were then postfixed in 1% osmium tetroxide at +4°C for two hours, and after washing, dehydration and resin infiltration they were embedded in Epon. Sections, made with a diamond knife, were stained with lead citrate and uranyl acetate. The sections were investigated in a Philips CM 10 Transmission Electron Microscope working at 60 kV.

Throughout the present work chemical constituents were identified by thin layer chromatography (Culbertson 1972; Culbertson *et al.* 1981; Culbertson & Johnson 1982; Elix & Ernst-Russell 1993; Elix *et al.* 1988), high performance liquid chromatography (Feige *et al.* 1993) and comparison with authentic samples.

Buellia aeruginosa A. Nordin, Owe-Larsson & Elix sp. nov. Figure 1-2.

Habitu *Buelliae alboatrae* similis, sed differt thallo et apotheciis acida xanthonica continentibus; apotheciis vel pariete pycnidii pigmentum aeruginosum HNO_3 + purpureum continenti; cellulis excipuli magis elongatis vel uniformiter pigmentiferis, pariete vero sporae crassiore; perispora persistenti laeviore.

Type: Australia. NEW SOUTH WALES. Near Melville Point, 13 km SSE of Batemans Bay, 35°50'S, 150°12'E, 1-8 m, on steep seashore cliffs facing E, Moberg & Owe-Larsson A69:16, 15 Mar. 1992 (UPS, holotype; CANB, isotype).

Etymology: "aeruginosa" refers to the aeruginose pigment present in the apothecium.

Thallus up to 0.7 mm thick, in small patches or along crevices, whitish or with a slightly yellowish tinge, rimose to areolate. Prothallus sometimes present, blackish. Cortical layer consisting of dead cells interspersed with

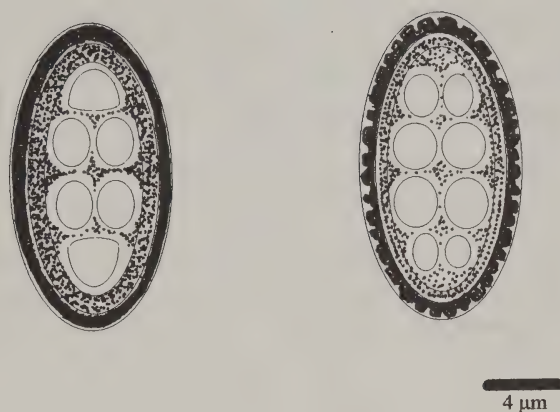


Figure 1. Spores of *Buellia aeruginosa* (left) and *B. alboatra* (right). Spore wall layers from the outside proceeding inwards: perispore (thin, gelatinous outer part, thicker, persistent inner part), intermediary layer (thin, indistinct), proper wall, endospore (unpigmented innermost part). In *B. aeruginosa* the persistent perispore part is smoother and the proper wall is thicker than in *B. alboatra*. Drawings based on TEM micrographs.



Figure 2. Type locality for *Buellia aeruginosa*.

calcium oxalate crystals and scattered ends of living hyphae; medulla with calcium oxalate crystals.

Apothecia abundant, first immersed in the thallus, eventually becoming sessile, up to 0.6 mm wide; disc black, urceolate to convex, with a thin whitish, C+ orange pruina of xanthone crystals; margin distinct but excluded on strongly convex apothecia, in young apothecia sometimes partly covered by thalline granules. Proper exciple 40-80 μm thick, consisting of elongate cells with thickened, dark brown walls, surrounded by a bluish green, HNO_3 + purplish pigment; hymenium hyaline in central part, in upper and lower part slightly coloured by the bluish green pigment, without oil droplets, c. 85 μm thick; epithecium blackish green; subhymenial layers dark brown, in upper part with a greenish tinge. Paraphyses simple or branched in uppermost part, apical cells widened and with pigmented caps; asci clavate, 45-55 $\times$ 15-25 μm . Ascospores brown, ellipsoid, submuriform, septation somewhat irregular, mature spores usually with 6 cells in optical section, 14-17 $\times$ 7-10 μm ; perispore with a thin gelatinous part, persistent part formed by radially arranged material with very narrow, shallow cracks, visible only in greatly enlarged TEM micrographs, c. 0.3 μm thick; proper wall c. 0.5 μm (Fig. 1).

Pycnidia immersed or upper part slightly protruding, rounded to slightly elongate, c. 80 $\times$ 75 μm ; wall dark in upper part, with an aeruginose HNO_3 + purplish pigment, pale in lower part. Conidia fusiform to bacilliform, c. 4-5 $\times$ 1 μm .

Chemistry. - Thallus K-, C+ orange, P-. Isoarthothelin (major), 2,5-dichloronorlichexanthone (minor), arthothelin (trace), asemone (trace), 2,7-dichloronorlichexanthone (trace), thiophanic acid (trace).

Ecology. - *Buellia aeruginosa* is a saxicolous species found on steep cliffs along the seashore. The cliffs are composed of Devonian shale and claystone and vary from 5-8 m in height. Associated species include *Lecanora elixii* Lumbsch, *Pertusaria persulphurata* Müll. Arg., *P. subventosa* Malme, *Rimelia reticulata* (Taylor) Hale & Fletcher, *Sphinctrina tubaeformis* A. Massal., *Tylothallia pahiensis* (Zahlbr.) Hertel & Kiliyas, *Xanthoparmelia australasica* D. Gall., and *Xanthoria ligulata* (Körb.) P. James.

Distribution. - So far only known from the type locality in New South Wales, Australia (Fig. 2).

Notes. - The similarity with *Buellia alboatra* is mainly restricted to superficial characters, as both thallus and apothecia look alike. The thallus of both species also contains calcium oxalate and the spore size is similar. The distinguishing characters, however, are more numerous. In contrast to *B. alboatra* the apothecia and the pigmented parts of the pycnidia of *B. aeruginosa* contain an aeruginose N⁺ purplish pigment. The hyphae of the proper exciple have more elongated cells and more evenly and more distinctly pigmented walls. The apothecium discs are C⁺ orange, due to the presence of xanthonenes in the epithecium, visible as a thin whitish pruina (in *B. alboatra* the C⁻ pruina consists of calcium oxalate crystals). The spores differ by fewer cells in optical section (6 versus 8), a thicker proper wall and a smoother persistent perispore part (Fig. 1). Also the secondary chemistry is distinct. The thallus of *B. aeruginosa* is C⁺ orange and contains xanthonenes whereas *B. alboatra* lacks secondary products or contains norstictic acid.

There are several other *Buellia* species with pluriseptate spores containing xanthonenes, e. g. *Buellia geophila* (Sommerf.) Lynge, *B. oidalea* (Tuck.) Tuck., *B. triphragmioides* Anzi, and *B. vernicoma* (Tuck.) Tuck. Of these only *B. vernicoma* is saxicolous (also corticolous and lignicolous). This species also resembles *B. aeruginosa* in producing xanthonenes in the apothecia (the same applies to the corticolous and lignicolous *B. triphragmioides*). The spores of *B. vernicoma*, however, are smaller (c. 13 × 5 µm), lack longitudinal septa, and have a thinner proper wall and a much more rugulate persistent perispore. Like the other species mentioned above, it is not known from Australia.

The aeruginose N⁺ purplish pigment is not uncommon in the genus *Buellia* (Scheidegger 1993) but has been found in only one of the other species with pluriseptate spores, viz. *B. tolucae* de Lesd. (Nordin 1999). This species, however, differs in most other respects.

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DALDINIA SINGULARIS SP. NOV. FROM EASTERN RUSSIA AND NOTES ON SOME OTHER TAXA

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ABSTRACT

Daldinia singularis sp. nov., apparently specific to the host genus *Carpinus*, is described. It forms the anamorph and the teleomorph in agar culture. Anamorphs of *D. fissa*, *D. mexicana*, and an unnamed *Daldinia* are also described.

Key words: *Daldinia*, systematics, Xylariaceae

One of us (LV) has infrequently collected a small *Daldinia* from *Carpinus* in eastern Russia. We suspect that this fungus is host-specific. It produces the anamorph and teleomorph in agar culture. Because the combination of teleomorphic characteristics of this fungus is unique among *Daldinia* taxa, it is described here as new.

Color codes in descriptions follow Rayner (1970). JDR refers to the personal herbarium of J. D. Rogers.

Daldinia singularis Y.-M. Ju, L. Vasilyeva, & J. D. Rogers, sp. nov.

Figs. 1-4, 8, 9

Stromata globosa vel depressa-globosa, sessilia vel subsessilia, solitaria vel aggregata, levia vel tumulis perithecorum inconspicuis, 3-5 mm diam x 2-4 mm alta; externe rufobrunnea vel vestutate denigrata; subsuperficie granulis sanguineis conspersa, granulis purpureis vel incoloratis in KOH dissolutis; textura inter perithecia brunnea medullosa vel lignea; textura sub peritheciis zonis alternantibus composita, zonis fuscis medullosis vel ligneis, 0.3-0.4 mm crassis et zonis griseis vel brunneis medullosis vel ligneis, persistentibus, 0.2-0.4 mm crassis praedita. Perithecia obovoidea, 0.2 mm diam x 0.3-0.4 mm

alta. Ostiola obsoleta. Asci 90-110 μm longitudine tota x 6-7 μm crassi, partibus sporiferis 50-60 μm longitudine, stipitibus 35-50 μm longitudine, annulo apicali deminuto vel nullo, in liquore iodato Melzeri haud caerulescente. Ascosporae brunneolae, unicellulares, ellipsoideo-inequilaterales vel reniformes, apicibus late rotundatis, 9-11 x 4.5-5.5 μm , rima germinativa recta brevissima in latere convexo praeditae; perisporium in KOH indehiscens, leve; episporium leve.

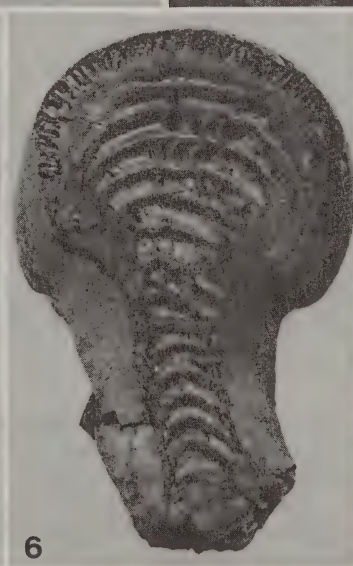
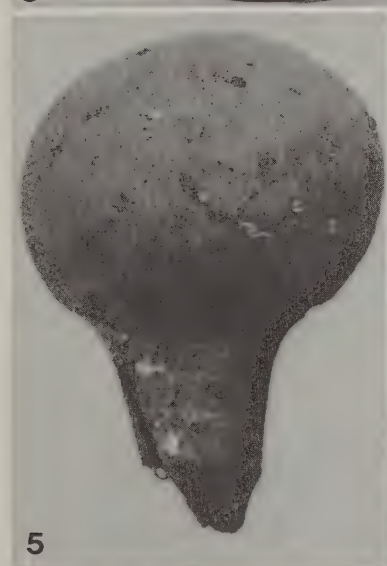
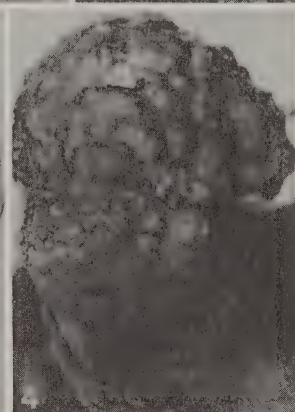
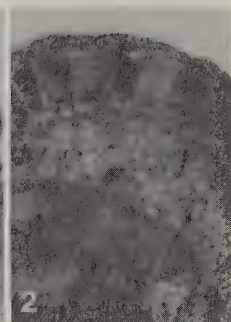
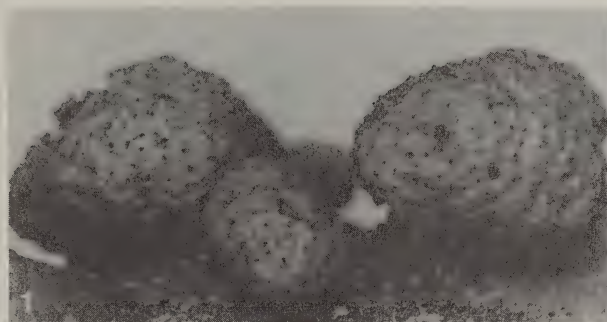
Stromata spherical to depressed-spherical, sessile to subsessile, solitary to aggregated, plane or with inconspicuous perithecial mounds, 3-5 mm diam x 2-4 mm high; surface dark reddish brown, blackened and dull in age; dull reddish brown granules immediately beneath surface, with KOH-extractable pigments purplish or without apparent KOH-extractable pigments; the tissue between perithecia brown, pithy to woody; the tissue below the perithecial layer composed of alternating zones, the darker zones dark brown, pithy to woody, 0.3-0.4 mm thick, the lighter zones gray or brown, pithy to woody, persistent, 0.2-0.4 mm thick. Perithecia obovoid, 0.2 mm diam x 0.3-0.4 mm high. Ostioles obsolete. Asci 90-110 μm total length x 6-7 μm broad, the spore-bearing part 50-60 μm long, the stipe 35-50 μm long, with apical ring highly reduced or lacking, not bluing in Melzer's iodine reagent. Ascospores light brown, unicellular, ellipsoid-inequilateral to reniform, with broadly rounded ends, 9-11 x 4.5-5.5 μm , with straight germ slit much less than spore-length on more convex side; perispore indehiscant in 10% KOH, smooth; episporium smooth.

Colonies on 2% Difco Oatmeal Agar at ca. 20°C and under 12 h fluorescent light reaching the edge of 9 cm Petri dish in 1.5 wk, whitish, felty, azonate, with diffuse margins, becoming buff (45) with sporulation; reverse citrine (13). Sporulating regions scattered over entire surface of colony. Conidiophores mononematous, dichotomously branched, hyaline, smooth or finely roughened, with intercalary coil-like twists at various lengths, 2.5-4 μm diam, with one conidiogenous cells arising from each terminus. Conidiogenous cells cylindrical, hyaline, smooth, 10-20 x 2.5-3.5 μm . Conidia produced from percurrently proliferating conidiogenous cells. Conidia hyaline, smooth, ellipsoid, with flattened base, 5.5-8 x 3.5-4.5 μm .

Teleomorph produced in stromata in 8-10 wk, homothallic, with morphological features as described for naturally-occurring material.

SPECIMENS EXAMINED: RUSSIA: Primorsky Territory, near Vladivostok, 26.IX.1997, Vasilyeva, L., (CULTURED), twigs of *Carpinus*

Figs. 1-7. *Daldinia singularis* and *D. sp.* Figs. 1-4. *D. singularis* (holotype). 1. Stromata on natural substrate; X6. 2. Vertical section of a stroma showing a perithecial layer and concentric rings; X16. 3. Culture on Oatmeal Agar with stromata produced at periphery; X0.66. 4. Stroma from culture, X6. 5-7. *Daldinia sp.* (L. Vasilyeva). 5. Stroma; X3. 6. Vertical section of a stroma showing a perithecial layer and concentric rings; X3. 7. Stromatal surface; X18.



cordata (VLA, HOLOTYPE; WSP, ISOTYPE); Primorsky Territory, near Vladivostok, 10.IX.1996, Vasilyeva, L., twigs of *Carpinus cordata* (VLA).

NOTES: This fungus is characterized by ascial apical rings that are highly reduced or lacking, ascospores with broadly rounded ends, ascospore germ slits that are much less than spore-length, and coil-like twists in the conidiophores. The stromata produced in culture matured in 3-4 wk after their initiation, forming 8-15 concentric rings inside. The ring formation in *D. singularis*, like that in *D. caldariorum* Henn. (Ju et al., 1997), did not involve abortive perithecia. Bayliss-Elliott (1920) believed that rings in *Daldinia* were the result of abortive perithecia, but our data on stromata that develop in culture indicate that this phenomenon is not universal and, indeed, may not occur at all.

The conidiophores of *D. singularis* have intercalary coil-like twists. This has not been found in other taxa of *Daldinia* with known anamorphs. The conidia are produced from percurrently proliferating conidiogenous cells. *Daldinia petriniae* Y.-M. Ju, J. D. Rogers, & San Martín is also known to produce conidia in a similar fashion but has a very different teleomorphic morphology (Ju et al., 1997).

This fungus is found occasionally on *Carpinus* and it is suspected to be host-specific.

Since the revisionary work on *Daldinia* (Ju et al., 1997) was published, we have obtained cultures from several *Daldinia* taxa. Descriptions of their cultures and anamorphs are given below.

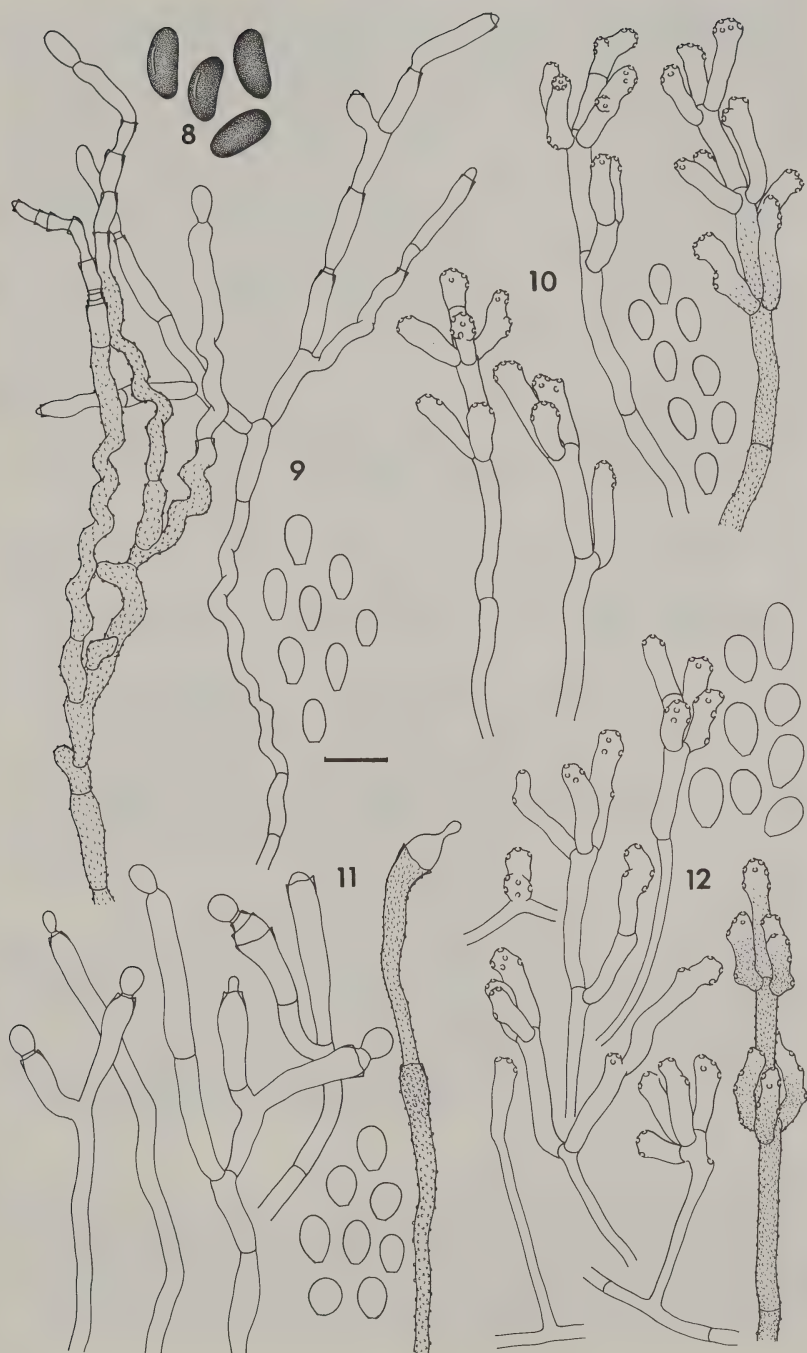
Daldinia fissa C. G. Lloyd, Mycol. Writings 7: 1313. 1924.

Fig. 12

See Ju et al. (1997) for a description of the teleomorph.

Colonies on 2% Difco Oatmeal Agar at ca. 20°C and under 12 h fluorescent light reaching the edge of 9 cm Petri dish in 1 wk, at first whitish, floccose, azonate, with diffuse margins, becoming greenish olivaceous (90) at places; reverse uncolored. Stromata confluent, distributed at edge of colony, pulvinate to hemispherical. Sporulating regions at edge of colony, largely confined on stromatal surface, buff (45) to vinaceous buff (86). Conidiogenous structure highly variable, ranging from *Sporothrix*-like, *Nodulisporium*-like to *Periconiella*-like branching pattern as defined in Ju and Rogers (1996). Conidiophores mostly arising from aerial hyphae on a slender, sometimes highly reduced, main axis 1.5-2 µm, mononematous, unbranched or di- or trichotomously branched, sometimes with additional

Figs. 8-12. *Daldinia singularis*, *D. mexicana*, *D. sp.*, and *D. fissa*. 8, 9. *D. singularis* (holotype). 8. Ascospores. 9. Conidiogenous structure and conidia. 10. *D. mexicana* (O. Govorova). Conidiogenous structure and conidia. 11. *D. sp.* (L. Vasilyeva). Conidiogenous structure and conidia. 12. *D. fissa* (H. Wollweber WW2899). Conidiogenous structure and conidia. The scale bar represents 10 µm.



branches arising from the first level of conidiogenous regions, hyaline, smooth to finely roughened, with one to four conidiogenous cells arising from each terminus. Conidiogenous cells cylindrical, hyaline, finely roughened, 8-20 x 3-4.5 μm . Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, subglobose to ellipsoid, with flattened base, 6.5-9(-11) x 4.5-6 μm .

Stromata produced in culture in 6-8 wk, with morphological features as described for naturally-occurring material, with ascomatal initials developing at stromatal periphery but never attaining full maturity.

SPECIMEN EXAMINED: GERMANY: D.-Wuppertal, 31.VIII.1996, Wollweber, H., WW2899 (CULTURED), charred *Fagus silvatica* (JDR).

NOTES: The cultures and anamorphs that we observed are in general as those described by Martin (1969) except for the conidia being broader, 4.5-6 μm vs. 3.7-4.3 μm . The conidiogenous structure is usually born on an aerial hypha and has a slender main axis. The stromata produced in culture form white and dark brown alternating concentric rings as found in their naturally-occurring counterparts. Once again, the ring formation in *D. fissa* did not involve abortive perithecia (also see NOTES on *D. singularis*).

Daldinia mexicana San Martín, Y.-M. Ju, & J. D. Rogers, Mycotaxon 61: 275. 1997. Fig. 10

The teleomorph is much as described in Ju et al. (1997) except for the ascospores being slightly larger, 14.5-17 x 7.5-8 μm vs. 12.5-15.5 x 6.5-7.5 μm .

Colonies on 2% Difco Oatmeal Agar at ca. 20°C and under 12 h fluorescent light reaching the edge of 9 cm Petri dish in 2 wk, whitish, felty, slightly zonate, with diffuse margins, with amber (47) pigments diffused beyond colonies, becoming dull green (70) at center and primrose (66) to honey (64) towards margins; reverse citrine (13). Sporulating regions at margins of colonies, buff (45). Conidiogenous structure with *Periconiella*-like branching pattern as defined in Ju and Rogers (1996). Conidiophores mononematous, composed of main axis and, infrequently, one major branch, hyaline, smooth to finely roughened, 3-3.5 μm diam, with two to four conidiogenous cells arising in whorls along main axis and major branch. Conidiogenous cells cylindrical, hyaline, roughened, 8-15 x 2.5-4 μm . Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, ellipsoid, with flattened base, 4.5-6.5 x 2.5-3.5 μm .

NOTES: The type locality of *Daldinia mexicana* is Mexico. Unfortunately, cultures were not obtained from Mexican collections (Ju et al., 1997). The current collection is from eastern Russia and has a teleomorph much as the Mexican collections.

***Daldinia* sp.** from Russian Far East

Fig. 5-7, 11

This collection agrees with *D. cudonia* (Berk. & M. A. Curtis) C. G. Lloyd, which is mainly known from the tropical and subtropical Americas, in having smooth, dark brick (60) stromatal surface, consistent, brown and dark brown alternating rings inside the stromata, purplish stromatal pigments in 10% KOH, brown to dark brown, ellipsoid-inequilateral ascospores 13-15 x 6.5-7

μm , a spore-length ascospore germ slit, and a dehiscent ascospore perispore. Although the stromatal stipes are frequently present, they lack apparent constricted rings and appear stouter than those in *D. cudonia*.

Colonies on 2% Difco Oatmeal Agar at ca. 20°C and under 12 h fluorescent light reaching the edge of 9 cm Petri dish in 1-1.5 wk, whitish, felty, azonate, with diffuse margins, becoming buff (45) to honey (64) with sporulation; reverse citrine (13). Sporulating regions scattered over entire surface of colony. Conidiogenous structure with *Sporothrix*-like or, rarely, *Nodulisporium*-like branching pattern as defined in Ju and Rogers (1996). Conidiophores mononematous, unbranched or dichotomously branched, hyaline, coarsely roughened, $2.5 \times 3 \mu\text{m}$ diam, with 1-2 conidiogenous cells arising from each terminus. Conidiogenous cells clavate, usually swollen at top, hyaline, roughened, $15\text{-}35 \times 4\text{-}6 \mu\text{m}$. Conidia produced from percurrently proliferating conidiogenous cells or, infrequently, from sympodially proliferating conidiogenous cells. Conidia hyaline, smooth, subglobose to obovoid, with a flattened base or attenuated flattened base, $6\text{-}7 \times 4.5\text{-}5.5 \mu\text{m}$.

SPECIMEN EXAMINED: RUSSIA: Primorsky Territory, near Vladivostok, 26.IX.1997, Vasilyeva, L., (CULTURED), *Carpinus cordata* (VLA; WSP).

NOTES: Although this fungus bears resemblance with *D. cudonia*, we are uncertain if it is conspecific with or even related to *D. cudonia*, which is distributed mainly in the tropical and subtropical Americas. A noticeable difference between the teleomorphs is that the present fungus has stout stromatal stipes that lack exterior constrictions. Like *Daldinia petriniae* and *D. singularis*, the present fungus also can produce conidia from percurrently proliferating conidiogenous cells. Unfortunately, there are no known cultural or anamorphic data from *D. cudonia* to make a comparison.

A Danish collection [DENMARK: Kropp, Scania, Sixeden, 31.XII.1994, Hanson, S.-Å., (CULTURED), pile of *Betula pendula* (JDR)] is apparently closely related to the present fungus but has larger ascospores $14.5\text{-}17 \times 7.5\text{-}9 \mu\text{m}$ and frequently an attenuated flattened base on the conidia. They may eventually be proven to be variants of a species.

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A NEW COMBINATION FOR *DIOICOMYCES* *BOURNIERI* (LABOULBENIALES)

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ABSTRACT

A new combination, *Dimeromyces bournieri*, is proposed for a species of Laboulbeniales previously described in the dioecious genus *Dioicomyces*. The study leading to this realignment was based on an examination of the type of *D. bournieri*, parasitic on a thrip (Phlaeothripidae; Thysanoptera).

Key words: *Dioicomyces*, *Dimeromyces*, Laboulbeniales, Madagascar, Thysanoptera.

INTRODUCTION

Dioicomyces bournieri Balazuc was described from specimens of fungi parasitizing a female of *Dolichothrips gutierrezi* (Bournier) (Thysanoptera, Phlaeothripidae) captured in Tananarive (Madagascar) (BALAZUC, 1972). For several years I have been working on a revision of *Dioicomyces*, and in the course of this study the type of *D. bournieri* was examined; however, because of bureaucratic difficulties the type slide was only recently received.

Prior to my examination of the type of *Dioicomyces bournieri*, I had concluded that several details given in Balazuc's description and illustrations of the taxon needed clarification: e.g., the characteristics of the male; the nature of the receptacle and perithegium of the adult female; and especially the depiction by Balazuc (1972, fig. 8) of a young female, which resembled nothing more than an *Alternaria*-like conidium. Also, the identity of the host, a thrip, is remarkable in being the only member of this common and widespread order of insects to be reported as the host of a laboulbenialean fungus.

From my previous studies of the type specimens and collection data of the other named taxa of *Dioicomycetes* (unpublished observations), I knew that only two species parasitized beetles not belonging to the family Anthicidae, i.e., *D. myrmecophilus* T. Majewski on a species of *Myrmecixenus* (Coleoptera: Tenebrionidae) (MAJEWSKI, 1994) and *D. floridanus* (Thaxt.) Thaxt. on a species of *Bledius* (Coleoptera: Staphylinidae) (THAXTER, 1908). It was critical that I study not only specimens of *D. bournieri* but also its host.

The slide I received in loan from the PC herbarium bearing the type of *D. bournieri* included also a female paratype of the insect host. The label read "*Dolichothrips Dolicholepta gutierrezii* (A. Bournier), Madagascar, Tananarive, 17-II-66, legit Gutierrez, *Vernonia appendiculata*". The fungus was very difficult to study because most of the thalli still were attached on the cuticle of the host. Also, the mounting medium used in preparing the slide was Canada Balsam, which is wholly inadequate for preserving Laboulbeniales. I sought and was granted permission to renovate the slide by dissolving the balsam in xylol and transferring the fragile insect and its parasites to Amman's solution.

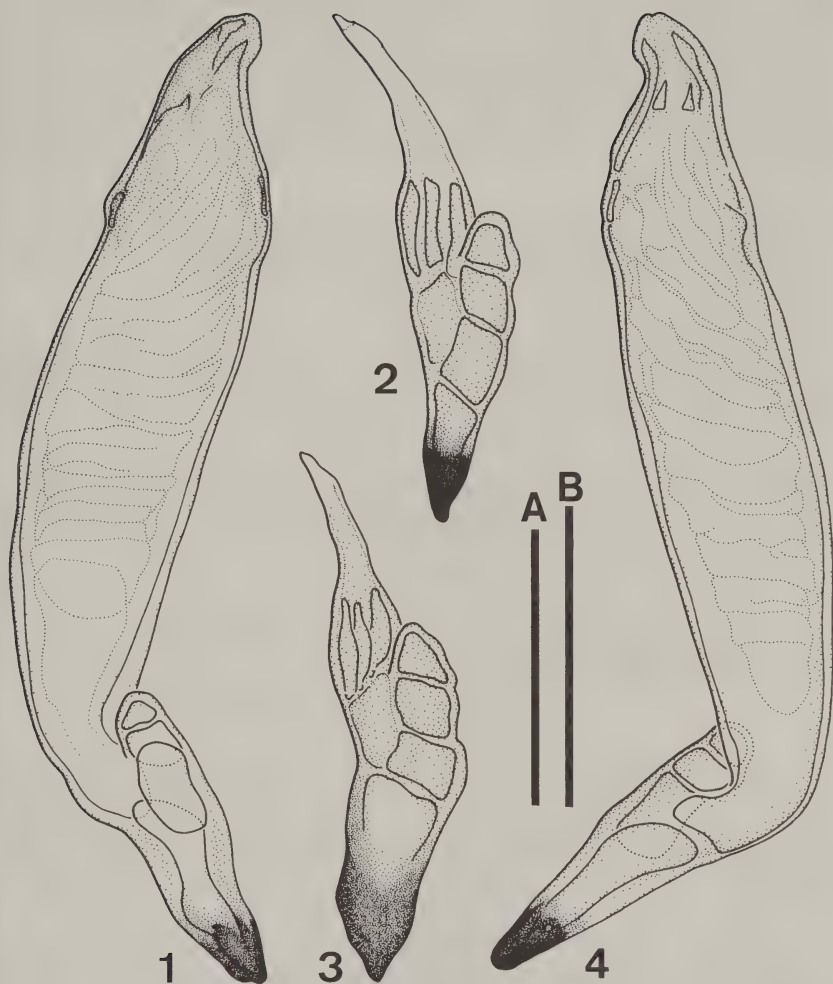
My attempted repair of the slide was successful, and the fungus could be adequately studied. The number of detached female thalli of *Dioicomycetes bournieri* exceeded 20 with several others still attached to various parts of the insect. Also, many immature thalli were found on the integument. The structure of the female (Figs. 1, 4), especially the perithecium with its undistinguished stalk cells and basal cells, identified it as belonging to *Dimeromyces*. Unfortunately, only two males were observed (Figs. 2, 3), and these were attached to the lower lateral surface of the thorax of the host. Although these males were difficult to study, their characteristics could be determined and placed them too in *Dimeromyces*. Thus, I here propose the transfer of *Dioicomycetes bournieri* to *Dimeromyces*.

TAXONOMY

***Dimeromyces bournieri* (Balazuc) Santam., comb. nov.**

- = *Dioicomycetes bournieri* Balazuc, Bull. Soc. Entomol. France 76: 228. 1972 [nom. nud.]
- = *Dioicomycetes bournieri* Balazuc, Acta Mycol. 11: 55. 1975 [nom. inval.]
- = *Dioicomycetes bournieri* Balazuc ex Santam., hoc opus [basion.]

Male thallus amber colored. Primary appendage as in the female. Suprabasal cell of receptacle bearing laterally a single compound flask-shaped antheridium having a trapezoidal stalk-cell; efferent neck slightly bent laterally. Total length to tip of antheridium 46-48 μm . Antheridium, without stalk 23-26 x 7 μm . Total length to tip of primary appendage 27-32 μm .



Figs. 1-4. *Dioicomycetes bournieri* (PC, Balazuc 77-64). Lectotype. **Figs. 1, 4.** Female thalli. **Figs. 2-3.** Male thalli. (Scale bar A = 25 μ m for figs. 2-3. Scale bar B = 50 μ m for figs. 1 and 4.)

Female thallus amber colored, slightly suffused with brown nears the perithecial apex in aged, mature specimens. Primary appendage consisting of two superposed cells, the upper cell hemispherical, the lower cell $\pm$ square; the two cells separated by a transverse septum. Perithecium single, arising

laterally from the suprabasal cell of the receptacle, which is twice as long as broad. Perithecium slightly curved at the narrow base, then nearly straight, long and somewhat fusiform; neck tapering abruptly above the subterminal tier of wall cells, which are externally convex and slightly darkened; apex blunt, bent laterally. Total length to tip of perithecium 140-154 μm . Total length to tip of primary appendage 45-50 μm . Perithecium including stalk 126-140 x 27-31 μm .

LECTOTYPUS [here designated].- In PC herbarium, Balazuc no. 77-64. On *Dolichothrips gutierrezii* (Bournier). Madagascar: Tananarive, 17 Feb. 1966, leg. Gutierrez, on *Vernonia appendiculata* Less. (Asteraceae).

Although BALAZUC (1975) published a Latin diagnosis -lacking in his previous description (BALAZUC, 1972)- for his *Dioicomycetes bournieri*, he failed to designate a type; therefore, according to the rule 37.1 of I.C.B.N. (GREUTER et al., 1994) his taxon remained a *nomen invalidum*.

Dimeromyces is a large and diverse genus with at least 100 currently known taxa, and species have been found on representatives of many families of arthropods belonging to both insects (Coleoptera, Dermaptera, Diptera, Isoptera) and mites (Acarina) (TAVARES, 1985). Thus, the addition of another order of insects, i.e., Thysanoptera, to the list of hosts of *Dimeromyces* is of great interest to students of Laboulbeniales, but it is not surprising in view of the known host range of the genus.

ACKNOWLEDGMENTS

The author wishes to thank F. Pando (Curator of MA Herbarium) for arranging the loan of the type slide of *Dioicomycetes bournieri*; the Curator of PC Herbarium for granting the loan; and R.K. Benjamin for critically reading the manuscript. This research was supported by DGES project no. PB-95-0129-C03-01 ("Flora Micológica Ibérica III").

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TWO NEW SPECIES OF XANTHOPARMELIA (ASCOMYCOTINA, PARMELIACEAE) FROM NORTH AMERICA

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ABSTRACT: The following new lichen species are described; *Xanthoparmelia commonii* Elix & Nash and *X. eganii* Elix & Nash. *Xanthoparmelia neowyomingica* Hale is described as a new record for Mexico.

Introduction

As a result of a continuing study of the lichen genus *Xanthoparmelia* in North America (Culberson *et al.* 1979; Nash 1973, 1974a, b, c; Nash & Elix 1986; Nash & Zavada 1977), we are describing two new species. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson *et al.* 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993; Elix *et al.* 1988), high performance liquid chromatography (Feige *et al.* 1993) and comparison with authentic samples.

***Xanthoparmelia commonii* Elix & Nash, sp. nov.**

Fig. 1

Thallus ut in *Xanthoparmeliae digitiformis* simili sed lobis maculatis, laciniis convexis vel subconvexis et rhizinis modicis et parce ramosis differt.

Type: MEXICO. Chihuahua: Sierra Madre Occidental, ridgecrest area along a secondary dirt road to Casas Grandes from Bavispe (Sonora), open pinyon pine - juniper - manzanita area, 2180 m, 30°24'20"N, 108°24'20"W, on acidic pebbles, 18 July 1994, T. H. Nash III 36422; holo: ASU; isotypes distributed as ASU Lichenes Exsiccati no. 349 (CANB, MEXU, US).

Thallus foliose, loosely adnate, to 10 cm wide. *Lobes* separate to imbricate, flat to weakly or moderately convex, sublinear, subdichotomously to subirregularly branched, 1-3 mm wide, becoming densely lacinate; *laciniae* convex, sublinear-elongate, di- or trichotomously branched, 0.4-1.0 mm wide. *Upper surface* yellow to yellow-green, flat to convex, shiny or dull, weakly maculate, smooth, lacking isidia and soredia. *Medulla* white. *Lower surface* canaliculate or not so, shiny, ivory to pale brown; *rhizines* moderately dense, simple, $\pm$ tufted or rarely branched, brown to brown-black, often extending beyond the lobe margins. *Apothecia* subpedicellate, 2-6 mm wide; disc concave then $\pm$ flat to undulating, mid to dark brown; *thalline exciple* smooth, margin thick and involute at first, then becoming dentate or $\pm$ densely lobulate. *Ascospores* $7-9.5 \times 4.5-6 \mu\text{m}$. *Pycnidia* common. *Conidia* bifusiform, $5-6 \times 0.5 \mu\text{m}$.

Chemistry. Cortex K-; medulla K+ yellow then dark red, C-, P+ orange; containing usnic acid, salazinic acid (major), consalazinic acid (minor).

This species is characterized by the loosely adnate thallus, the narrow, convex *laciniae*, the moderately dense *rhizines* which often project beyond the margins, the pale lower surface and the presence of the salazinic acid in the medulla. *Xanthoparmelia commonii* resembles the Southern Hemisphere species, *X. digitiformis* (Elix & P.M. Armstr.) Filson, in chemistry, in the narrow, elongate *laciniae* with a pale lower surface and the absence of vegetative propagules. *Xanthoparmelia digitiformis*, however, is clearly distinguished from *X. commonii* by the flat, emaculate lobes and *laciniae*, the sparsely rhizinate, rugulose lower surface with simple *rhizines* and elobulate *thalline exciple* of the *apothecia*. *Xanthoparmelia commonii* by contrast has short, sublinear lobes which are convex, lack *laciniae* and are densely rhizinate. *Xanthoparmelia commonii* also resembles the South African species *X. subconvoluta* Hale, but the latter has more strongly convoluted lobes, lacks *laciniae* and lobulate *apothecia*. *Xanthoparmelia commonii* is a relatively common in open habitats within the oak-pine forests of the Sierra Madre Occidental and may well be found further south. This species is named in honour of the American lichenologist Ralph E. Common, in recognition of his contributions to our understanding of the Parmeliaceae, and in particular, to the significance of the cell-wall polysaccharides.

Paratype and Isoparatype Specimens

MEXICO. Chihuahua: Sierra Madre Occidental, ca. 80 km W of La Junta along route 14, pine-oak woodland, 2290 m, $28^{\circ}45'N$, $107^{\circ}50'W$, on soil and pebbles, 9 June 1976, T. H. Nash III 13663 (ASU); along secondary dirt road S of Hacienda Casa de Adobe, open mixed conifer and oak forest, 1750 m, $30^{\circ}25'05''N$, $108^{\circ}27'45''W$, on mosses over pebbles, 17 July 1994, T. H. Nash III 36250 (ASU); Barranca del Cobre (Copper Canyon), 1 km S of Río Urique, mixed pine and oak forest, 1700 m, $27^{\circ}22'20''N$, $107^{\circ}30'10''W$, on rhyolite, 21 July 1994, T. H. Nash III 36780 (ASU); along small ridge within Barranca del

Cobre (Copper Canyon) above Basihuare with numerous rhyolite outcrops, shrubs (*Arctostaphylos* spp.) and scattered pines, 2000 m, 27°27'N, 107°29'20"W, on rhyolite, 21 July 1994, T. H. Nash III 37225 (ASU, CANB, MEXU, US); along secondary dirt road within the valley of Arroyo Ancho ca. 3 km W of paved road to Creel, rock outcrops along riverbank adjacent to pasture, 2150 m, 28°13'20"N, 107°30'W, on pebbles, 23 July 1994, T. H. Nash III 37433 & 37434 (ASU).

Xanthoparmelia eganii Elix & Nash, sp. nov.

Fig. 2

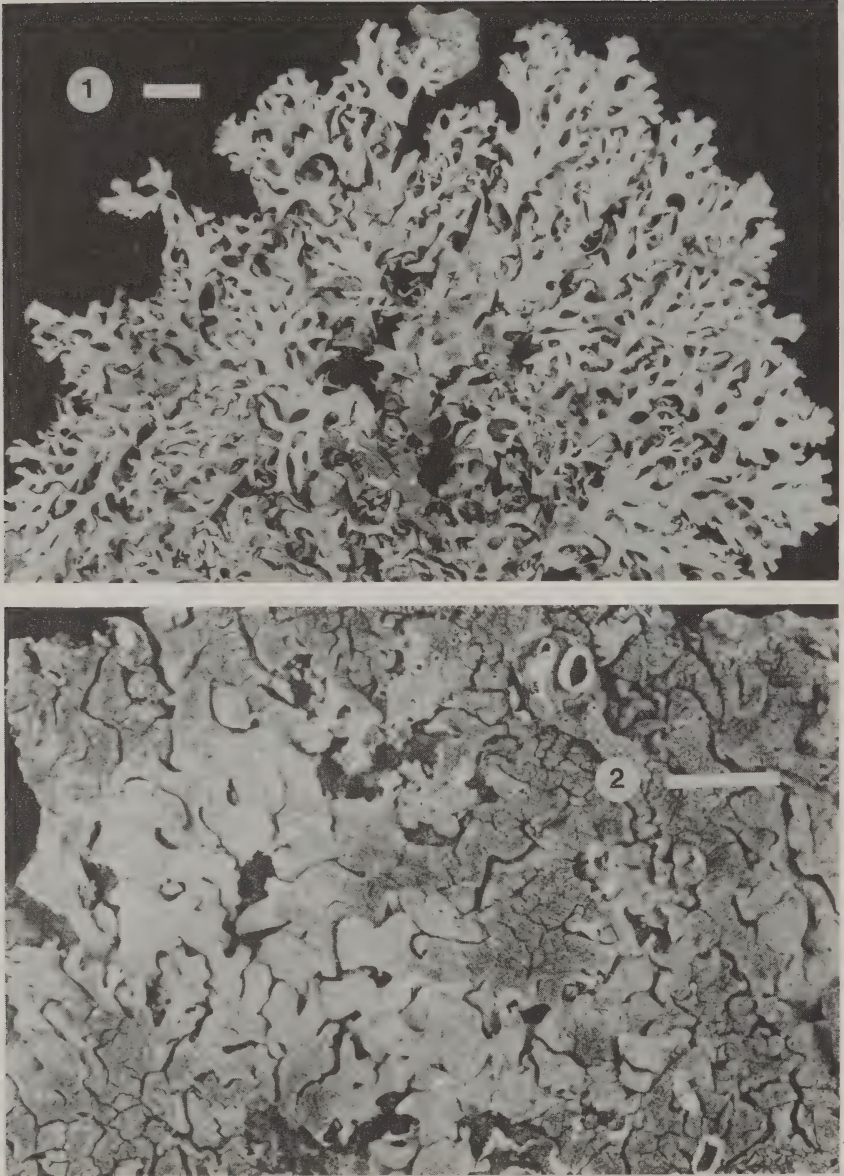
Species cum thallo ut in *Xanthoparmelia barbatica* sed ab hac specie thallo arcte adnato, sporis majoribus et acidum baeomycesicum, acidum squamaticum et acidum 3 α -hydroxybarbaticum continenti differt.

Type: UNITED STATES OF AMERICA. Texas: Presidio County, 19.2 km SE of Casa Piedra at Wire Gap, W end of South Canyon, 1220 m, on rock in mixed creosote-yucca-*Opuntia* desert, R. S. Egan E1-11219; holo: herb. R. S. Egan; iso-DUKE.

Thallus foliose, tightly adnate, 7-10 cm wide. *Lobes* barely imbricate or not so, contiguous, flat, sublinear, irregularly branched, 1.5-4.0 mm wide, apices $\pm$ subrotund; rarely becoming lacinate, laciniae sublinear, ca. 1 mm wide. *Upper surface* yellow-green but darkening with age, dull, shiny towards the lobe apices, emaculate, lacking isidia and soredia; older lobes becoming rugulose and irregularly or transversely fractured. Medulla white. *Lower surface* pale tan to brown; rhizines sparse to moderate, simple, brown to dark brown. *Apothecia* numerous, sessile, 1-2 mm wide; disc concave then undulating, dark brown; thalline exciple smooth, margin thick and involute at first, then becoming thin and crenate. Ascospores 9-12 $\times$ 5-6 μ m. *Pycnidia* common. Conidia bifusiform, 6-7 $\times$ 0.5 μ m.

Chemistry. Cortex K-; medulla K-, P-, C-, KC-; containing usnic acid, barbatic acid (major), 3- α -hydroxybarbatic acid (major/minor), 4-O-demethylbarbatic acid (major/minor/trace), baeomycesic acid (trace) and squamatic acid (minor/trace).

This species is characterized by the adnate to tightly adnate thallus, the broad, contiguous lobes with $\pm$ subrotund apices, the pale tan lower surface, the lack of maculae, isidia and soredia on the upper surface and production of barbatic, 3- α -hydroxybarbatic and 4-O-demethylbarbatic acids in the medulla. This species has previously been misidentified as the Australian species, *Xanthoparmelia barbatica* (Elix) Egan, since both have similar overall morphology and chemistry. *X. barbatica*, however, is clearly distinguished from *X. eganii* by being more loosely adnate, its more regular, sublinear lobes, the common development of extensive narrower (0.7-1.5



Figures 1-2. New species of *Xanthoparmelia*: 1, *X. commonii* (isotype in CANB); 2, *X. eganii* (holotype in herb. Egan). Scale bar = 5 mm.

mm wide), sublinear-elongate laciniae, its shorter spores (7-9 μ c. 9-12 μ m) and minor, but consistent chemical differences. Whereas *X. barbatica* invariably contains dehydroconstipatic acid (major) and traces of constipatic acid, these fatty acids do not occur in *X. eganii*. Furthermore, 3- α -hydroxybarbatic acid, baeomycesic acid and squamatic acid which are present in *X. eganii* have not been observed in *X. barbatica*. *X. eganii* is a rare species occurring on rocks in the desert of south-west Texas and in Chihuahua, Mexico. It is named in honour of the American lichenologist, Professor Robert S. Egan.

Paratype Specimens

MEXICO. Chihuahua: Sierra Madre Occidental, small S-facing canyon along the secondary dirt road N of Hacienda Casa de Adobe in a shrub dominated community, 1550 m, 30°40'25"N, 108°29'45"W, on rhyolite, 17 July 1994, T. H. Nash III 36218A (ASU); along secondary dirt road to Casas Grandes from Bavispe (Sonora), oak woodland area with some rhyolite outcrops, 1660 m, 30°21'50"N, 108°13'W, on rhyolite, 18 July 1994, T. H. Nash III 36514 (ASU).

New Record for Mexico

Xanthoparmelia neowyomingica Hale, *Mycotaxon* 34: 552 (1989).

Previously known from Colorado, U.S.A. and Colombia, Ecuador and Perú in South America.

Specimens Examined

MEXICO. Chihuahua: Sierra Madre Occidental, Sierra Madre Occidental, along secondary dirt road S of Hacienda Casa de Adobe, 30°25'05"N, 108°27'45"W, 1750 m, on mosses on pebbles over soil, 17 July 1994, T. H. Nash 36251 (ASU, CANB); ridgecrest area along a secondary dirt road to Casas Grandes from Bavispe (Sonora), open pinyon pine - juniper - manzanita area, 2180 m, 30°24'20"N, 108°24'20"W, on acidic pebbles, 18 July 1994, T. H. Nash III 36515 (ASU, CANB, MEXU, US, distributed as ASU Lichenes Exsiccati no. 350); along E bank of Río Sirupa, adjacent a secondary dirt road ca. 32 km W of Ciudad Madera, pasture with scattered oaks, 1340 m, 29°11'N, 108°19'25"W, on acidic rock, 20 July, 1994, T. H. Nash III 36646 (ASU, CANB, MEXU, US); along secondary dirt road within the valley of Arroyo Ancho ca. 3 km W of paved road to Creel, rock outcrops along riverbank adjacent to pasture, 2150 m, 28°13'20"N, 107°30'W, on pebbles, 23 July 1994, T. H. Nash III 37436 (ASU).

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MARTHANELLA NIDULOSA SP. ET GEN. NOV., A HYPOGEOUS BASIDIOMYCETE FROM NORTHERN ARIZONA, U.S.A.

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ABSTRACT

The genus *Marthanella* gen. nov. is proposed to accommodate the unique characteristics of the species *M. nidulosa* sp. nov., a hypogeous, gasteroid basidiomycete collected from the southwest United States. Its taxonomic placement is uncertain but it is most closely related to the monotypic genera *Gasterosporium* and *Arachnion*. The persistent, triplex peridium and subgelatinous gleba containing peridioles lined with a distinct hymenium are among the characteristics supportive of the establishment of a new genus and possibly a new family of gasteromycetes.

INTRODUCTION

Several collections of an unusual and apparently uncommon fungus were made during a survey for hypogeous fungi in mixed deciduous and conifer forests of the Mogollon rim in north-central Arizona. Examination of the specimens revealed a relationship to the monotypic gasteromycetous genera *Gasterosporium* Mattir. of the Gasterosporiaceae and *Arachnion* Schwein. of the Arachniaceae. A detailed study of the basidiomata has led us to conclude that this species cannot be satisfactorily included in any previously described genus. Therefore we have provided morphological evidence on which to establish a new genus and its single species, *Marthanella nidulosa* sp. nov. A discussion of its taxonomic and systematic relationships within the gasteromycetes is also presented.

MATERIAL AND METHODS

Freehand thin sections of fresh and dried basidiomata were mounted in 5% KOH for microscopic measurements and observation. Melzer's reagent (IKI) was employed to determine amyloidity and cotton blue was used to determine cyanophily. SEM and light photomicrographs were made with Zeiss instruments. Recorded spore dimensions based on 20 spores measured to the nearest 0.5 µm.

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DESCRIPTIONS

Marthanella States & Fogel, gen. nov. Figs. 1-3

Basidiomae hypogaeae, globosae vel subglobosae; peridio triplici; strato externo hyphis hyalinis implicatus composito; strato medio membranoso, ramosus ochraceis-fibrillis constituto; strato interno parenchymato et pseudoparenchymato constituto; gleba primo firma gelatinosa diende subpulverulenta, alba vel pallida olivacea-grisea, peridiolae parvissimae constituta; columella et capillitia desunt; basidiis ventricosis, 8-sporigeris; sporis ellipsoideis, hyalinis vel pallido luteo, pedicillis curtis. Typus: *Marthanella nidulosa* States & Fogel

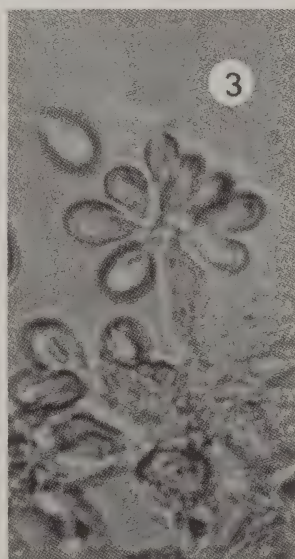
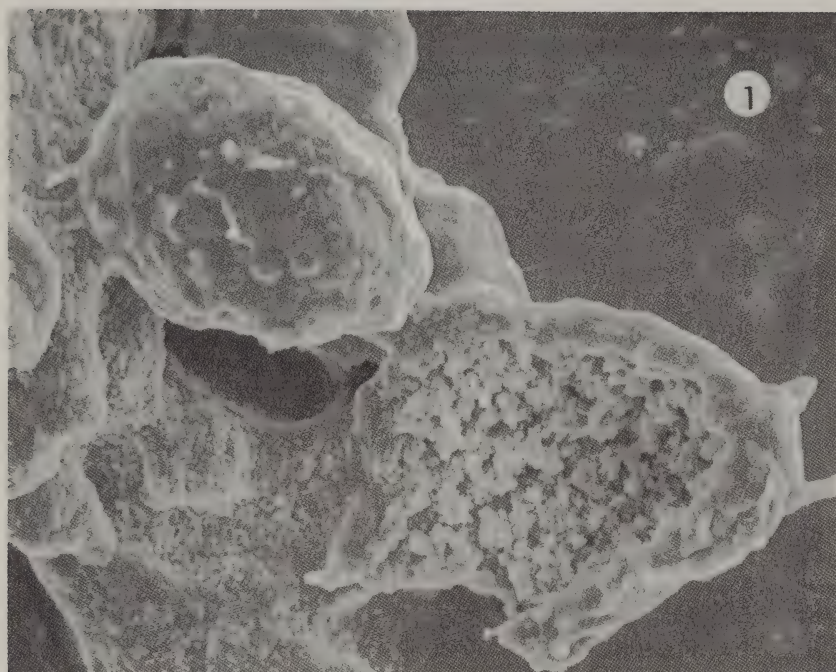
Basidiomata hypogeous, unevenly globose to subglobose. **Peridium** triplex, the outer layer deciduous in age, composed of loosely interwoven, thin-walled hyaline hyphae that intergrade with thick-walled hyphae of the medial layer below. Medial layer membranous and pliant composed of compactly interwoven, thick-walled ochraceous hyphae.. Innermost layer cellular (pseudoparenchymatous) mixed with swollen hyphal elements (prosenchyma), weakly gelatinized at maturity, layers separable as a unit from the gleba. **Gleba** white to light gray with occasional olivaceous tints, firm and somewhat gelatinous when young becoming granular and subpulverulent but remaining intact at maturity, composed of small peridioles that when sectioned cause the gleba to appear mottled; columella and capillitium absent. **Basidia** ventricose and 8-spored. **Spores** subglobose to mostly ellipsoid, hyaline to light yellow olivaceous in mass and viewed in refracted light, with a short pedicel.

Etymology: Named in honor of Dr. Martha Christensen, mentor and distinguished American mycologist.

Marthanella nidulosa States & Fogel sp. nov.

Basidiomae hypogaeae, globosae vel sublobosae, 5-20 mm. latae, albidae vel sublutescenti, tactu brunnescentes, siccitate brunnea; superficie floccosi diende coactili vel glabris; rhizomorphis paucis; peridio separabile, 600-850 μ m crasso, triplici; strato externo hyphis hyalinis implicatus composito; strato medio membranoso, ramosis ochraceis-fibrillis constituto; strato interno parenchymato intermixtis pseudoparenchymato, cellulis hyalinis; gleba albae vel pallido olivacea-grisea, in prima firma diende subpuverulenta, peridiolae parvissimae constitutae,

Figs. 1-3. *Marthanella nidulosa*. **1.** Peridioles, one broken open to reveal spore contents. Scanning electron microscopy (SEM), x350. **2.** Peridium cross section illustrating in descending order the outer, medial and inner peridial layers. The rounded interface of the glebal locules visible at the bottom of the inner layer. x1600. **3.** A typical ventricose, 8-spored basidium. x1600.



170-300 μm crassae, septis angustis hyphis hyalinis parallelibus compositis, circa 5-12 μm crassis (annumerato hymenio), locellis minutis, globosus vel irregularis, vacuis diende fartis; columella et tramatae desunt; basidii ventricosi, 8-sporigeris, 24-35 x 5.5-8.0 μm ; sporis ellipsoideis, (4.5) 5-7 (8) x 2.8-3.8 μm , hyalinis vel pallido-luteis; pedicellis curtis, ephemero; fibulae adsunt. Holotypus: States AHF-688.

Basidiomata hypogeous, unevenly globose to subglobose, 5-20 x 5-25 mm in diam, white to light buff, mottled with brown in age, surface cottony with adhering soil debris, later polished in exposed areas, produced singly or gregariously in a mycelial mat with rhizomorph-like strands attached at various points on the peridium.

Peridium triplex, the outer layer flocculent and somewhat deciduous, of various thickness, 200-800 μm , composed of loosely interwoven thin walled hyphae that overlie a tough membranous medial layer, 100-130 μm thick; the medial layer splitting open at maturity and persisting after release of glebal contents, composed of compactly interwoven, thick-walled, pigmented hyphae, these hyphae strongly dextrinoid and encrusted with ochraceous pigment debris; the innermost layer composed of subgelatinous pseudoparenchyma with hyaline, inflated terminal cells 10-15 μm diameter scattered throughout.

Gleba when young, firm, gelatinous and somewhat spongy, homogeneous, lacking distinct columella or capillitia, white becoming light gray sometimes with gray olivaceous tints, the cut sections exuding a small amount of clear viscous fluid which quickly dries to reveal small round empty locules surrounded by trama 15-35 μm thick. Gleba when mature is moist (subgelatinous) and somewhat granular (subpulverulent), remaining intact until desiccated or compressed, composed of many subglobose peridioles; Peridioles 200-300 μm in diameter, lined with basidia and stuffed to various degrees with spores, bounded by a fragile wall of parallel hyphae 5-12 μm thick which later disintegrates to release mature spores to the interior of the gleba. Clamp connections scattered and evident in the hymenium and medial peridium. Basidia 8-spored, hyaline, ventricose, 24-35 x 5.5-8.0 μm , with sterigmata highly visible below spores.

Spores smooth walled, subglobose to mostly elliptical, (4.5-) 5-7 x 2.8-3.8 μm (ave. 5.9 ± 0.58 x 3.6 ± 0.43 , l/w 1.66), hyaline, weakly dextrinoid in Meltzers reagent and light olivaceous yellow in KOH when viewed in mass, no reaction in cotton blue, some with indistinct oil droplets, walls slightly thickened, most with short pedicels 0.5-1.5 μm

Etymology: pertaining to the peridioles nested in the glebal matrix

Holotype: USA. Arizona. Coconino County, Oak Creek Canyon near Indian Gardens under Canyon live oak, *Quercus chrysolepis*, 7 April 1995, J. S. States (AHF-688). All voucher specimens are deposited in the University of Michigan Herbarium (MICH).

Habitat: A putative mycorrhizal associate of trees in mixed deciduous/conifer forests.

Other specimens examined: Arizona. Coconino Co.: Oak Creek Canyon near Indian Gardens, hypogeous under *Pinus pinyonensis* and *Quercus chrysolepis*; States AHF-690; Mahan Mountain Rd. intersection with Forest Hwy 3, under *Pinus ponderosa*, States AHF-691. Hila Co.: city limits of Payson under *Pinus ponderosa* and *Quercus gambellii*, States AHF-537.

DISCUSSION

The genus *Marthanella*, as typified by *M. nidulosa*, is a hypogeous, gasteroid basidiomycete. The distinctive characteristics which separate it from other described species to which it may be related include: hypogeous basidiomata; a persistent peridium of three layers, with the medial layer composed of differentiated hyphae typical of the dimitic hyphal system; rhizomorph-like mycelial strands instead of well defined rhizomorphs in the development of basidiomata, and a subgelatinous gleba which at maturity becomes granular forming separate spore bearing bodies that we have called peridioles. In contrast to the hardened walls of peridioles in the Nidulariales and the soft but persistent wall of peridioles in Pyrenogaster of the Lycoperdales, the thin walls of the peridioles are fragile and often disintegrate within the glebal chamber.

The exact taxonomic placement of *Marthanella* is uncertain but several characteristics of the basidioma show a strong affinity with two very unusual and infrequently encountered gasteromycetes, *Arachnion* Mattir. and *Gasterosporium* Schwein. Features of these genera held in common include: an auleate type of glebal development (Dring 1973); small locules lined with a hymenium that often develop as separate spore bodies or peridioles; and 8-spored basidia bearing pedicellate spores. The distinctive stellately arranged crystals in the exoperidium as noted by Miller and Askew (1982) for *Gasterosporium* are absent in *Marthanella*. The most significant morphological characteristics which compare and contrast their inter-generic relationships (Dring 1973, Monthoux & Rollin 1976, Miller and Miller 1988) are presented in Table 1.

It is tempting to speculate on the evolutionary patterns and relationships suggested by this comparison; relationships that might provide some direction for taxonomic placement of these genera. The possibility that any of these genera are related to groups of sequestrate hypogeous fungi, those considered to have been derived from spore-discharging ancestors, is precluded by the possession of pedicellate spores. As gastroid, monotypic genera, both *Arachnion* of the Arachniaceae and *Gasterosporium* of the Gasterosporiaceae have been placed in the Lycoperdales (Miller and Miller 1988), presumably on the basis of a powdery gleba. However, Dring (1973) included *Gasterosporium* with the Hymenogastrales on the basis of auleate development. Although it is not clear if *Arachnion* actually has this type of development, such is indicated by the formation of numerous small peridioles. *Marthanella* is auleate but the gleba is more gelatinous than powdery and

TABLE 1. BASIDIOMA CHARACTERISTICS OF THREE RELATED GASTEROMYCETES

	<i>Arachnion</i>	<i>Gasterosporium</i>	<i>Marthanella</i>
Position	epigeous	emergent	hypogeous
Peridium persistent	single, fragile	duplex, erodes at apex	triplex,
Rhizomorphs	several, stout	network, coarse	strand-like. soft
Gleba subgelatinous	powdery, grainy	powdery, mealy	granular,
Spore bodies	small peridioles	none reported	fragile peridioles
Spores	smooth, hyaline pedicellate	ornamented, yellow pedicels occasional	smooth, hyaline pedicellate
Capillitium	absent	paracapillitium	absent

thus its inclusion in the Lycoperdales appears unwarranted. A number of its characteristics, including auleate development, gelatinous gleba, persistent peridium, 8-spored basidia, and weakly developed rhizomorphs, are found in common with hypogeous members of the Hymenogastrales and the Phallales, but to which, if either, does it belong?

The comparative morphological evidence for these three genera provides support for an evolutionary hypothesis offered by Thiers (1984) to explain the origin of secotioid fungi as morphological intermediates between suilloid and sequestrate basidiomycetes. Essentially this hypothesis is based on the idea that forcible discharge of spores to the atmosphere in epigeous species was gradually compromised in favor of passive dispersal in hypogeous species. This proposed evolutionary process was driven by moisture availability as the principal selective factor and a morphological gradient from epigeous to hypogeous fruit-bodies was the product. The characteristics of *Arachnion* can be viewed (Table 1) as the morphological equivalent of an epigeous suilloid ancestor and those of *Marthanella* viewed as the hypogeous analog. Comparisons of mitochondrial DNA have helped to confirm evolutionary relationships between boletes and corresponding false-truffles (Bruns et al. 1989). A similar pattern may exist in the case of *Geastrum*, epigeous, and *Pyrenogaster*, hypogeous and with peridioles (Malençon and Rioussset 1977, Sunhede 1989). Because the overall morphological features and taxonomic relationships of hypogeous gasteromycetes are extremely complex, the placement of

Marthanella and related genera awaits further examination of morphological details, discovery of additional intermediates, and support from molecular genetic study.

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NEW SPECIES OF NEOFUSCELIA (LICHENIZED ASCOMYCOTINA, PARMELIACEAE) FROM THE SOUTHERN HEMISPHERE

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ABSTRACT : The following new species are described: *N. chudalupensis* Elix, *N. delisiella* Elix, *N. eldridgei* Elix, *N. franklinensis* Elix, *N. graniticola* Elix & Kantvilas, *N. leppii* Elix, *N. neoglabrans* Elix, *N. torulosa* Elix, *N. squamariatella* Elix and *N. subcrustulosa* Elix from Australia; *N. applicatella* Elix, *N. brandwagensis* Elix, *N. ceresella* Elix, *N. glomelliferonica* Elix, *N. lobarica* Elix, *N. namibiensis* Elix & Nash, *N. norincomposita* Elix & Nash, *N. polystictica* Elix, *N. subsquamariata* Elix and *N. wessellsii* Elix from South Africa. *N. squamariatella* also occurs in New Zealand. The new combination *Neofuscelia subprolixa* (Nyl. ex Kremp.) Elix is made.

Introduction

The lichen genus *Neofuscelia* Essl., a segregate of *Parmelia* Ach. *sensu lato*, was formerly recognized as *Parmelia* subgenus *Neofusca* (Gyeln.) Essl. It is characterized by a brown upper cortex which gives a blue-green to pale blue colouration with concentrated nitric acid, a lack of pseudocyphellae and soredia, medullary chemical diversity, a preference for rock and soil substrata, and a distinctly temperate distribution centred in the Southern Hemisphere. Esslinger (1978) raised *Neofuscelia* to generic level on the basis of its unique cortical chemistry, ascospore size, conidial shape and medullary chemistry. Although subsequent studies on cortical morphology using a scanning electron microscope were consistent with this conclusion (Lumbsch *et al.* 1988), the close relationship with *Xanthoparmelia* has been recognized by several authors (Elix *et al.* 1986) and recently confirmed by molecular studies (Crespo & Cubero 1998).

Southern Africa, Australia and New Zealand have been recognized as major centres of speciation of this genus (Elix 1994; Esslinger 1977) and despite an increase in taxonomic activity in recent years (Brusse 1984, 1987,

1991, 1993; Elix 1993, 1996, 1997a, 1997b, 1997c; Esslinger 1986a, 1986b; Kantvilas & Elix 1992; Krug & Sang 1995), a number of species remain to be described. This report presents descriptions of 20 new species.

Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson *et al.* 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993; Elix *et al.* 1988), high performance liquid chromatography (Feige *et al.* 1993) and comparison with authentic samples.

***Neofuscelia applicatella* Elix, sp. nov.**

Fig. 1

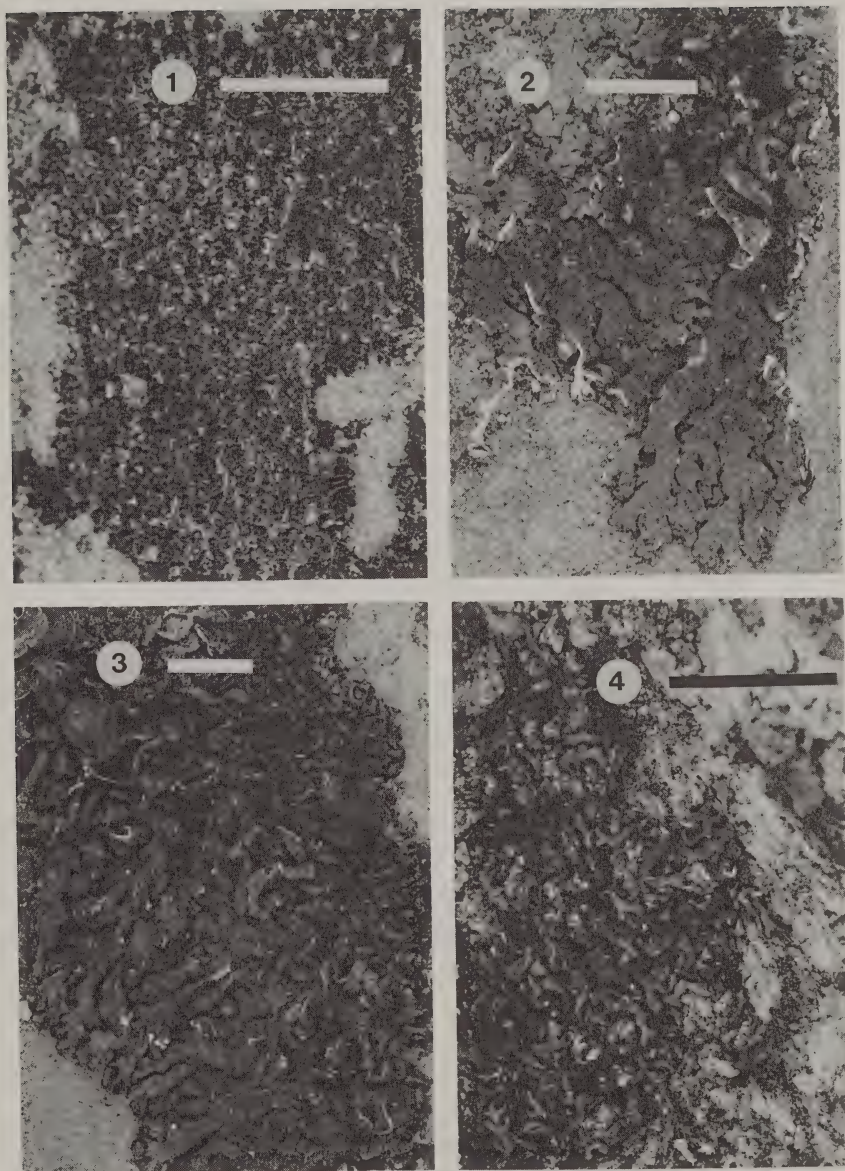
Species cum thallo ut in *Neofuscelia applicata* sed ab hac specie lobis angustioribus, sporis brevioribus et subnorlobaridonum et conorlobaridonumque noncontinenti differt.

Type: Republic of South Africa. Cape Province: Waboomsberg, ca. 30 m below summit, 33°38'S, 20°17'E, ca. 1200 m, on stones on ground, *D. Treibel* & *G. Rambold*, 8076, 31.iii.1990; holo: M.

Thallus subcrustose, very tightly adnate, saxicolous, 1-6 cm wide. Lobes contiguous to discrete, flat, irregular, short to sublinear, 0.1-0.5 mm wide. *Upper surface* black-brown to reddish brown, paler at the lobe apices, dull, or slightly shiny at the lobe apices, smooth, becoming fissured and markedly areolate in thallus centre, lacking soredia and isidia. Medulla white. *Lower surface* dull, not or only obscurely rhizinate, pale tan to brown; lower cortex in part agglutinated directly to substratum. *Apothecia* common, $\pm$ immersed when young, becoming sessile or subimmersed, to 0.8 mm wide; disc $\pm$ flat, dark brown; thalline exciple entire. *Ascospores* ellipsoidal, 6-7 x 4.5-5.5 μ m. *Pycnidia* common. *Conidia* bacilliform, 6-7 x 1 μ m.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K-, C-, KC+ rose, P-; containing norlobaridone.

Morphologically this species closely resembles *Neofuscelia applicata* (Stizenb.) Essl. in its habit, having very narrow, sublinear to subirregular lobes and a pale lower surface, and in containing norlobaridone in the medulla. However, *N. applicata* has a much thicker thallus with broader lobes (0.5-2.0 mm cf. 0.1-0.5 mm wide) than in *N. applicatella*, adnate to substipitate apothecia (rather than subimmersed) and contains conorlobaridone and subnorlobaridone which are consistently absent in the latter. Although these two species are chemically very similar, *Neofuscelia applicata* is always distinctly foliose in part and lacks the characteristic areolae present in the central parts of *N. applicatella*.



Figures 1-4. New species of *Neofuscelia*: 1, *N. applicatella* (Triebel & Rambold 8075); 2, *N. brandwagensis* (holotype in M); 3, *N. ceresella* (holotype in M); 4, *N. chudalupensis* (holotype in CANB). Scale bar = 5 mm.

Specimen Examined

REPUBLIC OF SOUTH AFRICA. Type locality, on stones on ground, *D. Triebel & G. Rambold*, 8075, 31.iii.1990 (CANB).

***Neofuscelia brandwagensis* Elix sp. nov.**

Fig. 2

Thallus ut in *Neofuscelia verisidiosa* sed superficie inferiore brunnea differt.

Type: Republic of South Africa. Orange Free State: Golden Gate Highlands National Park, Glen Ree-Brandwag trail below Wodehouse Kop, shortly before Brandwag, 20 m below chain ladder, 28°32'S, 28°38'E, 2030 m, *D. Triebel & G. Rambold* 6755, 8.iii.1990; holo: M; iso: CANB.

Thallus foliose, adnate, saxicolous, to 6 cm wide. Lobes imbricate, flat, irregular to sublinear, short, rounded, 1-2 mm wide. *Upper surface* red-brown to olive-brown or dark brown, paler at the lobe apices, shiny and strongly foveolate at the lobe apices, becoming dull and weakly rugulose on older parts of the thallus; isidia moderate to dense, globose then cylindrical, becoming branched; apices of isidia syncorticate, shiny, intact. Medulla white. *Lower surface* dull, pale to dark brown; rhizines moderate, simple, concolorous. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-, HNO₃+ dark blue-green, medulla K-, C-, KC+ rose-red, P-, UV+ blue-white; containing α -collatolic acid (major), alecoronic acid (minor), 4-O-methylphysodic acid (minor), β -collatolic acid (trace).

In gross morphology *N. brandwagensis* resembles the more common *N. verisidiosa* (Essl.) Essl., with both species having adnate, foliose thalli with an isidiate upper surface and containing α -collatolic acid and alecoronic acids. However, these two species differ in the colour of the lower surface. Whereas *N. verisidiosa* has a jet black lower surface, this is pale to dark brown in *N. brandwagensis*. At present this new species is only known from the type locality.

***Neofuscelia ceresella* Elix, sp. nov.**

Fig. 3

Species cum thallo ut in *Neofuscelia scabrosina* sed ab hac specie habitu arcte adnato, saxicolo, lobi plerumque laciniatibus, subto nigro subtus et acidum constipaticum et acidum protoconstipaticum noncontinenti differt.

Type: Republic of South Africa. Cape Province: Warmbokkeveld NE of Ceres, 1 km W of Swaarmoedpas, near road, 33°17'S, 19°30'E, 915 m, on flat, low boulders, *D. Triebel & G. Rambold* 8119, 30.iii.1990; holo: M.

Thallus foliose, adnate to tightly adnate, to 7 cm wide. *Lobes* contiguous or in part imbricate, flat, irregular to sublinear, irregularly branched, 1.5-3.0 mm wide, laciniolate in thallus centre; laciniae sublinear, subascending, 0.3-0.8 mm wide. *Upper surface* dark brown to black-brown, smooth, slightly shiny and olive-brown at margins, becoming dull, rugulose towards thallus centre, without isidia or soredia. *Medulla* white. *Lower surface* black with a dark brown zone at lobe apices; rhizines moderate, simple, black. *Apothecia* common, sessile to shortly stipitate, 3-5 mm wide; disc black-brown, concave at first but becoming more or less flat or undulating, margin thin, entire. Ascospores ellipsoid, 8-9 x 5-6 μm . *Pycnidia* common; conidia bifusiform, sometimes only weakly so, 6-8 x 1 μm .

Chemistry. Cortex K-, HNO_3 + dark blue-green, medulla K-, C-, P-; containing scabrosin 4-acetate-4'-butyrate (major), scabrosin 4-acetate-4'-hexanoate (major), scabrosin 4,4'-diacetate (minor/trace).

This species could be confused with *Neofuscelia scabrosina* Elix since both species have similar foliose thalli and contain scabrosin derivatives in the medulla. However, *N. ceresella* is a saxicolous species with a black lower surface which develops subascending laciniae in the thallus centre, whereas *N. scabrosina* lacks laciniae and is a terricolous species with a pale brown lower surface. The two species also exhibit chemical differences. Thus *N. scabrosina* contains the fatty acids, constipatic acid and protoconstipatic acid, and three scabrosin derivatives, whereas *N. ceresella* contains only scabrosin derivatives. Chemically this new species most closely resembles *N. scabrella* (Essl.) Essl., also from South Africa, but the latter species lacks the fatty acids, and is distinguished morphologically by the loosely adnate thallus with elongate, dichotomously branched, loosely entangled lobes. At present this new species is only known from the type locality.

Neofuscelia chudalupensis Elix, sp. nov.

Fig. 4

Species cum thallo ut in *Neofuscelia brussei* sed ab hac specie habitu laxo adnato, et lobis convexis, separatis et rhizinatisque differt.

Type: Australia. Western Australia: Mt Chudalup, 17 km SSE of Northcliffe, 34°46'S, 116°05'E, 185 m, on granite rock in large rocky outcrop with scattered shrubs in depressions, J. A. Elix 41152, H. T. Lumbsch & H. Streimann, 14 September 1994; holo: CANB.

Thallus minutely foliose to subcrustose, saxicolous, loosely adnate to adnate, 1-2 cm wide. *Lobes* not imbricate, separate, sublinear, subdichotomously to irregularly branched, 0.2-0.6 mm wide. *Upper surface* dark brown to black-brown, convex, shiny, lacking isidia and soredia, becoming areolate in thallus centre. *Medulla* white. *Lower surface* $\pm$ canaliculate, black; rhizines sparse to moderately dense, robust, $\pm$ becoming expanded and hapterate, black. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K-, HNO_3 + pale to dark blue-green, medulla K+ pale dull yellow, C-, P+ orange-red; containing fumarprotocetraric acid (major), protocetraric acid (minor).

Like *Neofuscelia brussei* Elix and *N. stygiodes* (Nyl. ex Cromb.) Essl., this new species is characterized by a minute foliose to subcrustose thallus, a black lower surface, the lack of isidia and the presence of medullary fumarprotocetraric acid. However, these three species differ in the configuration of the lobes and the morphology of the lower surface. Thus the lobes are flat and thin, and contiguous or weakly imbricate in *N. brussei*, thin, convex and separate in *N. chudalupensis*, but are strongly convex, thick, contiguous and placodioid at the apices in *N. stygiodes*. Furthermore, the lower surface is dark brown to black, lacking rhizines but with loboid holdfasts in *N. stygiodes*, jet black, erhizinate and attached via the lower cortex in *N. brussei*, but jet black and sparsely to moderately rhizinate in *N. chudalupensis*. At present this new species is only known from the type locality.

***Neofuscelia delisiella* Elix, sp. nov.**

Fig. 5

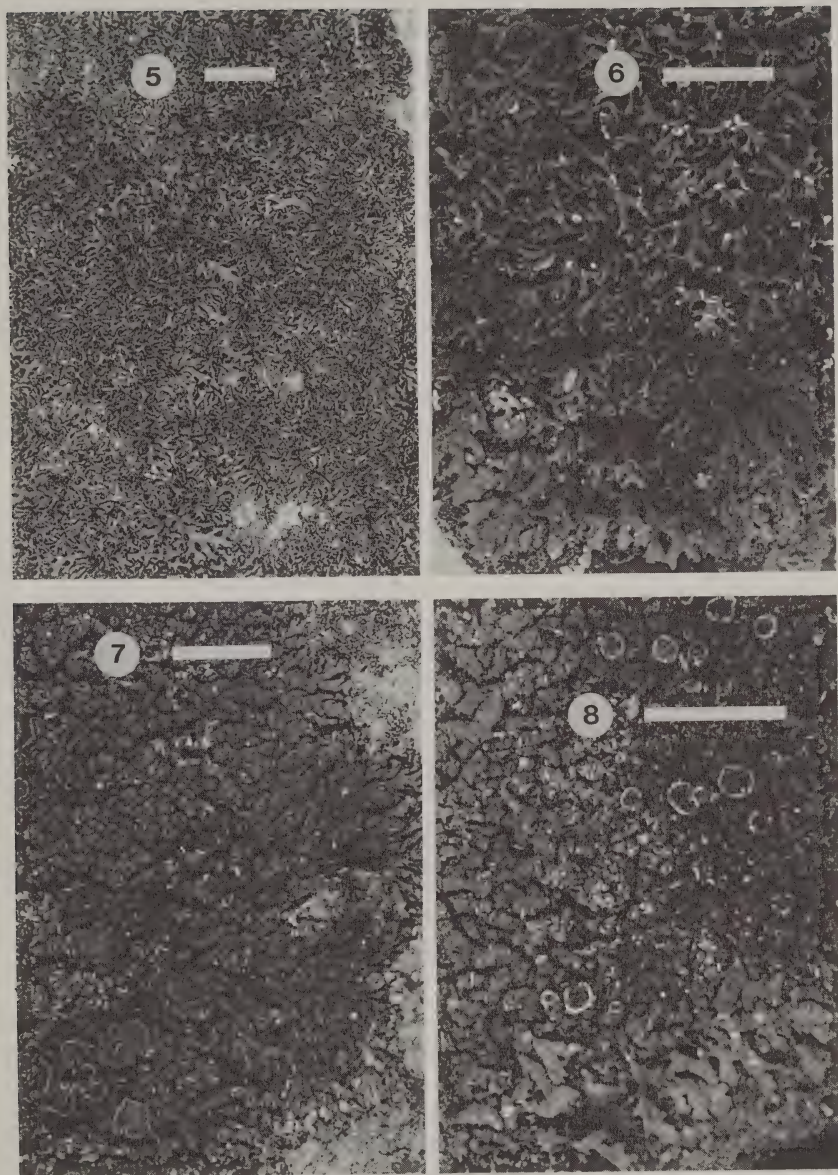
Species cum thallo ut in *Neofuscelia delisei* sed ab hac specie habitu arcte adnato, lobis diminutis, separatis et acidum 2-O-methylglomellifericum continenti differt.

Type: Australia. Victoria: Mt Raymond, 13 km E of Orbost, 37°43'S, 148°36'E, 290 m, on exposed granite outcrop in regrowth *Eucalyptus* forest, J. A. Elix 19456, 27.ix.1985; holo: CANB.

Thallus foliose, tightly adnate, to 7 cm wide. Lobes imbricate, radiating, flat, sublinear-elongate, 0.2-0.5(-1.0) mm wide, without laciniae. Upper surface smooth, slightly shiny and olive-brown at margins, becoming dull, rugulose, cracked and dark brown towards thallus centre, without isidia. Lower surface black with a paler brown zone at lobe apices; rhizines moderately dense, simple, black. Pycnidia and apothecia not seen.

Chemistry. Cortex K-, HNO_3 + pale to dark blue-green, medulla K-, C-, KC+ rose-red, P-, UV-; containing glomelliferic acid (major), perlatolic acid (minor), stenosporic acid (minor), 2-O-methylglomelliferic acid (minor/trace).

This species is characterized by the small, tightly adnate thallus, sublinear-elongate lobes with a black lower surface, the lack of isidia and the presence of perlatolic, stenosporic, glomelliferic and 2-O-methylglomelliferic acids in the medulla. It resembles *N. delisei* (Duby) Essl. in chemistry, the lack of



Figures 5-8. New species of *Neofuscelia*: 5, *N. delisiella* (holotype in CANB); 6, *N. eldridgei* (holotype in CANB); 7, *N. franklinensis* (holotype in CANB); 8, *N. glomelliferonica* (holotype in M). Scale bar = 5 mm.

isidia and the black lower surface, but differs in that *N. delisei* has a loosely to moderately adnate thallus and much broader lobes (1-4 mm wide). Although both taxa contain the same chemosyndrome of depsides, their actual chemical profiles differ significantly. In particular, *N. delisea* lacks 2-O-methylglomelliferic acid, but contains glomellic acid (major/submajor) and loxodellic acid (minor). At present *N. delisoides* is only known from the type locality.

***Neofuscelia eldridgei* Elix, sp. nov.**

Fig. 6

Species *Neofusceliae luteonotatae* simili sed ab hac specie lobis laciniatis et laciniis subcylindricis differt.

Type: Australia. South Australia: 6 km E of Sedan, 34°34'S, 139°20'E, 80 m, on soil in mallee scrub, J. A. Elix 9302, 28 Oct. 1981; holo: CANB.

Thallus foliose, terricolous, moderately to loosely adnate, to 7 cm wide. *Lobes* imbricate, flat or slightly convex at the apices, becoming more strongly convex towards thallus centre, sublinear to subirregular, 1.0-3.0 mm wide, irregularly branched; *lacinae* developing at periphery, along the lobe margins or within thallus, terete to subterete, $\pm$ subfruticose, sublinear to linear-elongate, dichotomously to subdichotomously branched, 0.3-0.8(1.0) mm wide. *Upper surface* dark brown to chocolate-brown, paler at the thallus periphery, dull to slightly shiny at the apices, smooth or becoming rugose, lacking soredia and isidia but initials of *lacinae* (tubercles) often appearing isidia-like. *Medulla* white. *Lower surface* pale brown to brown, dark brown at the apices, $\pm$ canaliculate, moderately rhizinate; rhizines dark brown to black, short, simple or occasionally tufted, slender, often projecting beyond margins. *Apothecia* uncommon, short stipitate, 1-3 mm wide; disc concave, becoming $\pm$ flat or undulate, black-brown; thalline exciple thin, entire, rugose. *Ascospores* 8-9 $\times$ 5-6 μ m. *Pycnidia* common. *Conidia* bifusiform, 5-7 $\times$ 1 μ m.

Chemistry. Cortex K-, HNO₃+ dark blue-green, medulla K-, C-, P-, UV-; containing divaricatic acid (major), nordivaricatic acid (trace), stenosporic acid (minor/trace).

This new species appears to be related to *Neofuscelia luteonotata* (J. Steiner) Essl. as both species have foliose, non-isidiate thalli with a pale lower surface and identical chemistry. However, they can be separated clearly by their morphology. Whereas *Neofuscelia luteonotata* usually lacks *lacinae* (or occasionally has small, $\pm$ flat *lacinae*) and is adnate to tightly adnate on rocks, *N. eldridgei* has prominent, distinctly terete to subterete *lacinae* and is adnate to loosely adnate on soil. This new species occurs scattered on soil in arid and subarid areas of southern Australia. It is named in honour of Dr

David Eldridge, noted for his contributions to the knowledge of soil crusts in arid and semi-arid rangelands in Australia.

Specimens Examined

AUSTRALIA. Victoria: Bendigo district: paddock adjoining Whipstick - Millwood road, 11.5 km NNE of Huntly, 36°34'S, 144°20'E, ca. 160 m, on soil in cleared mallee with very sparse herb layer, *J. Johnston* 1591 11.xii.1984 (CANB). South Australia: Koonalda Station, Nullarbor Plain, on soil, *D. McVean* 6616, (CANB, COLO).

***Neofuscelia franklinensis* Elix sp. nov.**

Fig. 7

Species cum thallo ut in *Neofuscelia stygiodes* sed ab hac specie isidiis lobulatis, superficie inferiore pallido castanea et acidum gyrophoricum continenti differt.

Type: Australia. Australian Capital Territory: Brindabella Range, summit of Mt Franklin, 45 km WSW of Canberra, 35°29'S, 148°47'E, 1644 m, on schistose stones in subalpine grassland with scattered *Eucalyptus pauciflora*, *J. A. Elix* 43018, 11.i.1999; holo: CANB.

Thallus small foliose to subcrustose, tightly adnate, saxicolous, to 5 cm wide. Lobes contiguous to imbricate, convex centrally, almost flat or convex at apices, irregular to sublinear, 0.8-1.5 mm wide, with subascending laciniae, laciniae sublinear, subirregularly branched, 0.4-1.0 mm wide. *Upper surface* olive-brown to black-brown, paler and shiny at the lobe apices, dull and becoming rugose, fissured and subareolate in older parts of the thallus, sparsely lobulate-isidiate; lobulate isidia coralloid-branched, subcylindrical at apices; apices syncorticate, blacked, shiny, intact. *Medulla* white. *Lower surface* shiny, pale tan to brown, wrinkled, lacking rhizines; attached to the substratum by loboid holdfasts. *Apothecia* common, sessile, 3-5 mm wide; disc weakly concave, becoming flat, then undulate distorted and gyrose; thalline exciple rugulose, entire. *Ascospores* ellipsoidal, containing oil drops, 8-11 × 5-6 µm. *Pycnidia* common. *Conidia* subbifusiform, 6-8 × 1 µm.

Chemistry. Cortex K-, HNO₃+ dark blue-green, medulla K-, C+ pink, KC+ pink, P-; containing gyrophoric acid (major), lecanoric acid (minor/trace).

Superficially *N. franklinensis* resembles *N. stygiodes* (Nyl. ex Croub.) Essl., with both species having tightly adnate, small foliose to subcrustose thalli with closely contiguous, centrally subareolate lobes, lacking rhizines and being attached via rhizoid holdfasts. However, these two species differ in a number of respects. Whereas *N. stygiodes* lacks isidia, has a black lower surface and contains fumarprotocetraric acid, *N. franklinensis* has coralloid branched lobulate isidia, a pale lower surface and contains gyrophoric acid. The presence of gyrophoric acid and lobules are reminiscent of *N. minuta*

Essl., but this species has narrower (0.25-0.6 mm cf. 0.8-1.5 mm wide), flat lobes with a brown-black lower surface and the lobules do not become isidiate. At present this new species is only known from the type collection.

***Neofuscelia glomelliferonica* Elix, sp. nov.**

Fig. 8

Species cum thallo ut in *Neofuscelia pyrenaica* sed ab hac specie nigro subtus et acidum norglomelliferonicum praecipue continenti differt.

Type: Republic of South Africa. Transvaal: Long Tom Pass between Sabie and Lydenburg, 25°05'S, 30°37'E, 2149 m, on sandstone, T. H. Nash 23434, 16.i.1986; holotype: ASU.

Thallus small-foliose, adnate to tightly adnate, saxicolous, from 4-6 cm wide. *Lobes* weakly imbricate or contiguous, flat, sublinear to subirregular, 0.5-1.5(-2.0) mm wide, $\pm$ lacinate in the centre, laciniae sublinear, 0.2-0.5 mm wide. *Upper surface* dark, chocolate brown, dull in the centre but shiny and $\pm$ pruinose at lobe apices, $\pm$ smooth and flat at periphery, becoming rugose, fissured and cracked within, without isidia. *Lower surface* dull, smooth, black; rhizines sparse to moderate, simple. *Apothecia* common, sessile, 1-2 mm wide; disc concave at first, becoming $\pm$ flat or undulate, dark brown; thalline exciple entire. *Ascospores* ellipsoid, 8-9 $\times$ 5-6 μ m. *Pycnidia* common. *Conidia* weakly bifusiform, 6-7 $\times$ 1 μ m.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K-, C+ rose, KC + pink-violet, P-; containing glomelliferonic acid (major), norglomelliferonic acid (submajor), colensoic acid (minor), stenosporonic acid (minor), glomellonic acid (minor), norcolensoic acid (trace).

This species is characterized by the tightly adnate to adnate thallus, the black lower surface, the absence of isidia, and the presence of glomelliferonic and norglomelliferonic acids in the medulla. *Neofuscelia glomelliferonica* resembles the better known southern European - North African species, *N. pyrenaica* (Essl.) Essl., as both lack isidia, have foliose thalli and contain glomelliferonic acid. However, *N. pyrenaica* differs in having a pale tan to dark brown lower surface (jet black in *N. neopyrenaica*) and quantitative chemical differences [*N. pyrenaica* contains glomellonic acid (major), glomelliferonic acid (major), norglomelliferonic acid (minor), and colensoic acid (minor)]. *Neofuscelia glomelliferonica* appears to be rare on rocks in the mountains of southern Africa (Transvaal, Orange Free State, Lesotho). In his description of *N. pyrenaica*, Esslinger (1977) mentions several aberrant specimens with a dark lower surface from Lesotho, and these obviously belong to the present new species. This is the first reported natural occurrence of norglomelliferonic acid and the detailed chemistry will be reported elsewhere (Elix *et al.*, in preparation). The characteristic chromatographic data for this substance follows: standard TLC R_F values, R_F (A) 0.20; R_F (B) 0.20; R_F (C) 0.25; standard HPLC, R_T 23.8 min.; R_I 0.24.

Specimen Examined

REPUBLIC OF SOUTH AFRICA. Orange Free State: Qwa-Qwa, Witzieshoek, peak just S of Sentinel Car Park, 28°44'S, 28°53'E, ca. 2550 m, D. Triebel & G. Rambold 6937, 12.iii.1990 (M).

***Neofuscelia graniticola* Elix & Kantvilas, sp. nov.**

Fig. 9

Species *Neofusceliae remnantiae* simili sed ab hac specie isidiis cylindricis et acidum barbaticum et acidum 4-O-demethylbarbaticum continenti differt.

Type: Australia. Tasmania: Mt Cameron, 40°59'S, 147°56'E, 350 m, on moist, flat granite rocks in dry sclerophyll forest, G. Kantvilas 130/97 & J. A. Elix, 22 April 1997; holo: HO.

Thallus small-foliose to subcrustose in the centre, adnate to tightly adnate, to 3 cm wide. Lobes not or very sparingly imbricate, $\pm$ contiguous, sublinear, subdichotomously branched, 0.2–0.6 mm wide. *Upper surface* dark brown, dull throughout or slightly shiny at lobe apices, $\pm$ smooth, flat to mainly convex, becoming fissured, subareolate, moderately isidiate; isidia cylindrical, simple for the most part or sparingly branched, to 0.3 mm high, with syncorticate, intact apices. Medulla white. *Lower surface* dull, smooth, black, canaliculate in part, sparsely rhizinate; rhizines simple, black. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K-, C-, KC-, UV-; containing barbatic acid (major), 4-O-demethylbarbatic acid (minor/trace).

This species is characterized by the diminutive, $\pm$ subcrustose thallus, the convex upper surface, the black lower surface, the presence of cylindrical isidia, and barbatic acid in the medulla. Morphologically *N. graniticola* resembles *N. remnantia* Elix since both species have similar minute thalli and convex lobes with a black lower surface, but these species differ in the nature of the isidia and medullary chemistry. Thus in contrast to *N. graniticola*, *N. remnantia* has sparse, simple, globose isidia and contains 4-O-methylphysodic acid (major), α -collatolic acid (trace) and physodic acid (trace). *Neofuscelia graniticola* is the first isidiate *Neofuscelia* known to contain barbatic acid, and could be considered the isidiate counterpart of the primary fertile species, *N. atrobarbatica* (Elix) Essl. At present it is only known from the type locality.

***Neofuscelia leppii* Elix, sp. nov.**

Fig. 10

Species cum thallo ut in *Neofuscelia verisidiosa* simili sed ab hac specie terricolo, lobis laciniatis, isidiis $\pm$ lobulatis et inflatisque differt.

Type: Australia. South Australia: 6 km E of Sedan, 34°34'S, 139°20'E, 80 m, on soil in mallee scrub, *J. A. Elix* 26359, 24 Sept. 1991; holo: CANB; iso: HO.

Thallus foliose, terricolous, moderately to loosely adnate, to 8 cm wide. *Lobes* imbricate, flat or slightly convex at the apices, becoming more strongly convex towards thallus centre, sublinear to subirregular, 1.0-3.0 mm wide, irregularly branched; laciniae developing at periphery, along the lobe margins or within thallus, terete to subterete, sublinear-elongate, subdichotomously branched, 0.3-0.8 mm wide. *Upper surface* black-brown to chocolate-brown, paler at the thallus periphery, dull to slightly shiny and $\pm$ pruinose the apices, smooth or becoming rugose, isidiate; isidia globose at first, then subcylindrical, $\pm$ irregularly inflated or lobulate, with apices syncorticate, intact. *Medulla* white. *Lower surface* black, sparsely to moderately rhizinate; rhizines black, short, simple or occasionally tufted, slender. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-, HNO_3 + dark blue-green, medulla K-, C-, P-, UV+ blue-white; containing alecatoronic acid.

This new species appears to be related to *Neofuscelia verisidiosa* Essl. as both species have foliose thalli with a black lower surface, contain alecatoronic acid and have an isidiate upper surface. However, they can be separated clearly by their substrate preference and the morphology of the isidia. Whereas *N. verisidiosa* is adnate to tightly adnate on rocks and dead wood and has slender (0.08-0.15 mm diam.) cylindrical isidia and usually lacks laciniae (or occasionally has small, $\pm$ flat laciniae), *N. leppii* is adnate to loosely adnate on soil, has robust (0.20-0.50 mm diam.), globose to subcylindrical isidia with $\pm$ inflated apices, and/or lobulate, $\pm$ dorsiventral isidia and terete or subterete laciniae. This new species occurs scattered on soil in mallee areas of South Australia and is named in honour of the Australian mycologist, Mr Heino Lepp.

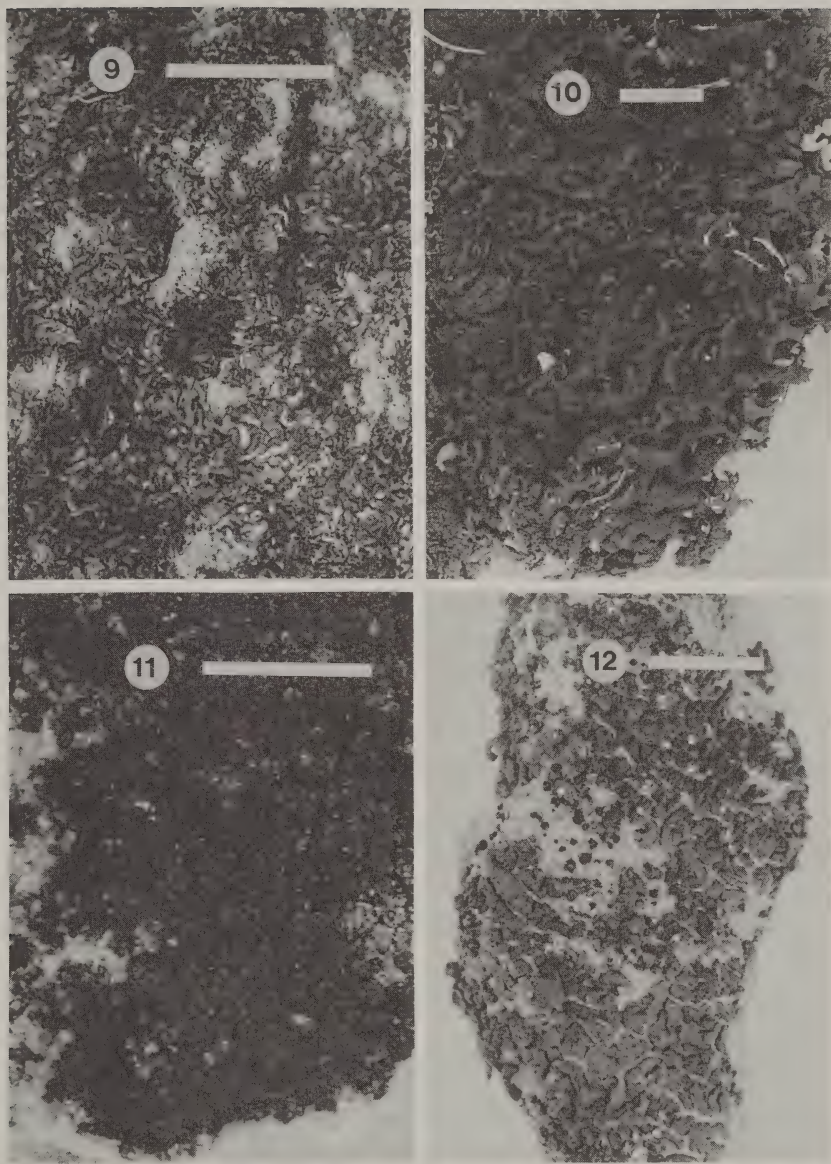
Specimens Examined

AUSTRALIA. South Australia: Mt Lofty Ranges, 10 km ENE of Springton along the Marne River, 34°40'S, 139°11'E, 240 m, on soil in dry pasture, *J. A. Elix* 4196, 27.xii.1977 (CANB); 5 km N of Sedan, 34°33'S, 139°18'E, 100 m, on soil in mallee scrub, *J. A. Elix* 8764, 30.viii.1980 (CANB); 17 km W of Blanchetown along Hwy. 20, 34°21'S, 139°27'E, 80 m, on soil in mallee scrub, *J. A. Elix* 9280, 28.x.1981 (CANB).

***Neofuscelia lobarica* Elix, sp. nov.**

Fig. 11

Species cum thallo ut in *Neofuscelia remnantia* sed ab hac specie lobis contiguis sed imbricatis, angustioribus, isidiis cylindricis et acidum lobaricum continenti differt.



Figures 9-12. New species of *Neofuscelia*: 9, *N. graniticola* (holotype in HO); 10, *N. leppii* (holotype in CANB); 11, *N. lobarica* (holotype in M); 12, *N. namibiensis* (holotype in ASU). Scale bar = 5 mm.

Type: Republic of South Africa. Cape Province: Leeukop (Lion's Head) west of Cape Town, NE of summit, 33°56'S, 18°23'E, 669 m, on boulders and rocks, *D. Treibel & G. Rambold*, 8299, 5.iv.1990; holo: M; iso: CANB.

Thallus subcrustose, very tightly adnate, saxicolous, to 4 cm wide. *Lobes* contiguous to imbricate, flat, irregular, short to sublinear, 0.1-0.3 mm wide. *Upper surface* black-brown to black, dull, paler and sometimes slightly shiny at the lobe apices, smooth, becoming fissured, areolate and moderately isidiate towards the centre of the thallus; isidia short cylindrical, simple, with syncorticate, intact apices. Medulla white. *Lower surface* black, erhizinate; lower cortex attached directly to the substratum. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K-, C-, KC-, P-; containing lobaric acid.

This species resembles the Australian *Neofuscelia remnantia* Elix in its habit, having very narrow, sublinear to irregular lobes, an isidiate upper surface and a black lower surface. However, *N. remnantia* has separate, somewhat broader lobes (0.2-0.5 mm *cf.* 0.1-0.3 mm wide) in contrast to the narrower, imbricate to contiguous lobes of *N. lobarica*, sparse, globose isidia (rather than moderately dense, cylindrical isidia) and contains 4-O-methylphysodic acid (major), α -collatolic acid (trace), physodic acid (trace) rather than lobaric acid. Lobaric acid has not been observed in any other species of *Neofuscelia*. At present *N. lobarica* is only known from the type locality.

***Neofuscelia namibiensis* Elix & Nash, sp. nov.**

Fig. 12

Species cum thallo ut in *Neofuscelia incomposita* sed ab hac specie norlobaridonum continenti differt.

Type: Namibia. Omaruru District: gravel flats 6.5 km NE of Cape Cross turn-off, 21°37'S, 14°02'E, 50 m, on pebbles, *T. H. Nash* 23314, 9.i.1986; holo: ASU.

Thallus small foliose to subcrustose, very tightly adnate, saxicolous, to 2 cm wide. *Lobes* discrete to slightly imbricate, weakly to distinctly convex, sublinear to linear, 0.3-0.8(-1.0) mm wide, subdichotomously branched. *Upper surface* black brown to dark reddish brown, dull, paler, $\pm$ slightly shiny and smooth at the lobe apices, soon becoming fissured, rugulose and areolate, lacking soredia and isidia. Medulla white. *Lower surface* pale tan to brown, smooth, flat or slightly channeled, dull, sparsely rhizinate; rhizines simple, concolorous, to 0.2 mm long. *Apothecia* scattered, substipitate, to 1.5 mm wide; disc weakly concave to flat, dark brown to black-brown; thalline exciple entire. *Ascospores* globose to subglobose, 5-6 $\times$ 5 μ m. *Pycnidia* common. *Conidia* bifusiform, 6-7 $\times$ 1 μ m.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K+ yellow then orange, C-, KC+ red, P+ orange-yellow; containing salazinic acid (major), norlobaridone (minor), consalazinic acid (minor).

Morphologically, this species closely resembles *Neofuscelia incomposita* (Essl.) Essl. in its habit, having narrow, linear to sublinear, convex lobes, and in containing salazinic acid in the medulla. However, whereas *N. incomposita* contains additional alecutoronic acid as a minor medullary substance, *N. subincomposita* contains norlobaridone and no traces of alecutoronic acid. This and a number of morphologically similar species belong to the so-called *N. namaensis* (J. Stein. & Zahlbr.) species group (Esslinger 1977). At present this new species is only known from the type collection.

***Neofuscelia neoglabrans* Elix, sp. nov.**

Fig. 13

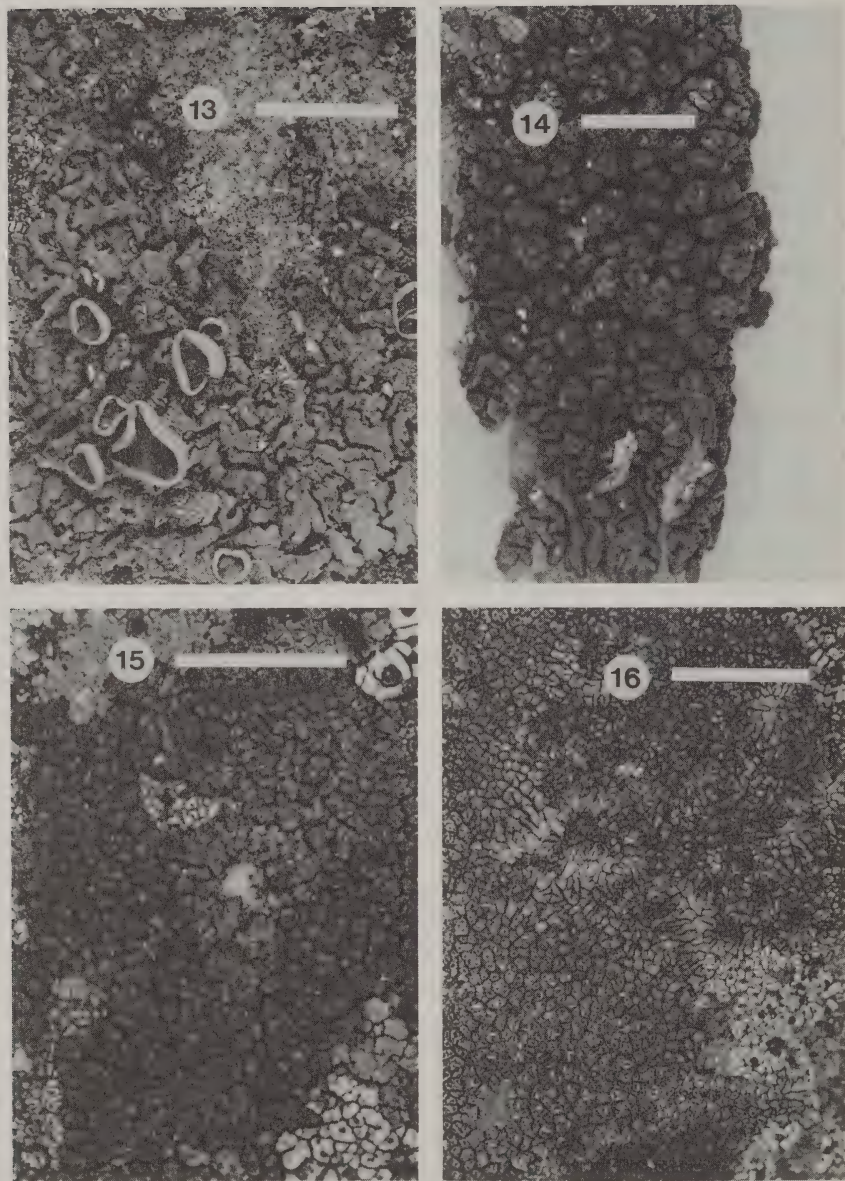
Species *Neofusceliae glabrans* simili sed thallo arcte adnato et superficie inferiore pallido brunnea differt.

Type: Australia. South Australia: South Mt Lofty Ranges, along Saunders Creek, 6.5 km E of Springton, 34°42'S, 139°10'E, 300 m, on schist rocks in pasture and dry *Eucalyptus* woodland, J. A. Elix 23505, 2.i.1990; holo: CANB.

Thallus small-foliose or foliose, adnate to tightly adnate, terricolous or saxicolous, 1-4 cm wide. *Lobes* weakly imbricate or not, flat to convex, sublinear to irregular, 0.5-1.5 mm wide, lacking laciniae. *Upper surface* dark, chocolate brown, dull throughout or slightly shiny at lobe apices, ± smooth and flat at periphery, convex and ±grey pruinose within, becoming rugose, fissured and cracked, without isidia. *Lower surface* ±dull, smooth, tan to dark brown, often mottled; rhizines sparse to moderate, simple, concolorous or becoming darker. *Apothecia* common, sessile or short pedicellate, 1-4 mm wide; disc concave at first, becoming ±flat or undulate, dark brown to black; thalline exciple entire, ±pruinose. *Ascospores* 7-9 × 5-6 µm. *Pycnidia* common. *Conidia* weakly bifusiform, 6-7 × 1 µm.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K-, C-, KC+ red, P-, UV+ strong blue-white; containing alecutoronic acid.

This species is characterized by the tightly adnate to adnate thallus, the pale lower surface, the absence of isidia, and by the presence of alecutoronic acid in the medulla. *N. neoglabrans* resembles the much more common and widely dispersed *Neofuscelia glabrans* (Nyl.) Essl. as both lack isidia, have foliose thalli and contain alecutoronic acid. However, *N. glabrans* differs in having a loosely to moderately adnate thallus, broader lobes (0.5-3.0 mm wide cf. 0.5-1.5 mm wide) and a jet black lower surface. *N. neoglabrans* appears to be rare on rocks and soil along the eastern slopes of the Mt Lofty Ranges of South Australia.



Figures 13-16. New species of *Neofuscelia*: 13, *N. neoglabrans* (holotype in CANB); 14, *N. norincomposita* (holotype in ASU); 15, *N. polystictica* (Treibel & Rambold 8023 in M); 16, *N. squamariatella* (holotype in CANB). Scale bar = 5 mm.

Specimens Examined

AUSTRALIA. South Mt Lofty Ranges, above Saunders Creek, 6 km E of Springton, 34°42'S, 139°09'E, 350 m, on schist rocks in pasture with large schist outcrops, J. A. Elix 41968, 24.ix.1994 (CANB); along Gorge Creek, 10 km W of Mannum, 34°55'S, 139°17'E, ca. 100 m, on soil in rocky pasture, J. A. Elix 4235, 29.xii.1977 (CANB).

Neofuscelia norincomposita Elix & Nash, sp. nov.

Fig. 14

Species cum thallo ut in *Neofuscelia incomposita* sed ab hac specie lobis latoribus et acidum norsticticum praecipue continenti differt.

Type: Namibia. Swakopmund District: 30 km E of Swakopmund, 22°42'S, 14°51'E, 100 m, on pebbles on gravel flats, T. H. Nash 23296, 7.i.1986; holo: ASU.

Thallus small foliose to subcrustose, tightly adnate, to 3 cm wide. Lobes discrete to slightly imbricate, weakly to distinctly convex, sublinear to linear, 0.5-1.5 mm wide, subirregularly branched, apices $\pm$ placodiform. *Upper surface* black brown, dull, or slightly shiny at the lobe apices, smooth at apices but markedly plicate within, becoming fissured and areolate in thallus centre, lacking soredia and isidia. *Medulla* white. *Lower surface* pale tan to brown, smooth, flat or slightly channeled, dull, sparsely to moderately rhizinate; rhizines simple, concolorous. *Apothecia* scattered, sessile or substipitate, to 1 mm wide; disc concave to $\pm$ flat, dark brown; thalline exciple entire. *Ascospores* globose to subglobose, 5-6.5 $\times$ 4-5 μ m. *Pycnidia* common. *Conidia* bifusiform, 6-7 $\times$ 1 μ m.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K+ yellow then orange, C-, KC+ red, P+ orange-yellow; containing norstictic acid (major), alectoronic acid (minor), connorstictic acid (trace).

Morphologically this species closely resembles *Neofuscelia incomposita* (Essl.) Essl. in its habit, having narrow, linear to sublinear, convex lobes, and in containing alectoronic acid in the medulla. However, whereas *N. incomposita* contains salazinic acid as the major medullary substance, *N. norincomposita* contains norstictic acid and no traces of salazinic acid; the latter species also has somewhat broader lobes (0.5-1.5 mm cf. 0.3-1.0 mm wide). This and a number of morphologically similar species belong to the so-called *N. namaensis* (J. Stein. & Zahlbr.) species group (Esslinger 1977). At present this new species is only known from the type collection.

***Neofuscelia polystictica* Elix, sp. nov.**

Fig. 15

Species *Neofusceliae crustulosae* simili sed ab hac specie thallo tenuiore, erhizinato, lobis angustioribus et acidum sticticum et acidum norsticticum continenti differt.

Type: Republic of South Africa. Western Cape Province: Knersvlakte, between Vanrhijnsdorp and Bitterfontein, 280 km N of Cape Town, on rock in desert, *C. M. van Herk*, 27 Sept. 1997; holo: herb. Aptroot.

Thallus subcrustose, very tightly adnate, saxicolous, 1-3 cm wide. *Lobes* contiguous, flat, sublinear to irregular, short, 0.1-0.5 mm wide. *Upper surface* black-brown to dark reddish brown, dull, paler and shiny at the lobe apices, smooth at first, becoming fissured and areolate in thallus centre, lacking soredia and isidia. *Medulla* white. *Lower surface* dull, erhizinate, pale tan to brown; lower cortex in part agglutinated directly to substratum. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K+ yellow then pale red, C-, P+ orange; containing stictic acid (major), hypostictic acid (minor), norstictic acid (minor/trace), cryptostictic acid (minor), peristictic acid (minor/trace), constictic acid (minor/trace), methyl pseudocryptostictate (minor/trace), lusitana unknown (minor/trace), hypoconstictic acid (trace), methyl stictic acid (trace).

Morphologically this species resembles *Neofuscelia crustulosa* (Essl.) Essl. in its habit, having very narrow, sublinear to subirregular lobes and a pale lower surface, and in containing hypostictic and hypoconstictic acids in the medulla. However, *N. crustulosa* has a thicker thallus (0.15-0.25 mm cf. 0.10-0.15 mm thick) with broader lobes (0.5-1.0 mm cf. 0.1-0.5 mm wide) than in *N. polystictica*, is sparsely rhizinate (rather than erhizinate) and lacks stictic and norstictic acids present in the latter species. Indeed, *N. crustulosa* contains only hypostictic acid (major), hyposalazinic acid (minor) and hypoconstictic acid (trace). At present this new species is known from several locations in Cape Province and Western Cape Province in South Africa.

Specimens Examined

REPUBLIC OF SOUTH AFRICA. Cape Province: Waboornsberg summit, 33°38'S, 20°17'E, 1220 m, on boulders and rocks, *D. Treibel & G. Rambold* 7999, 31.iii.1990 (CANB), *ibid.* *D. Treibel & G. Rambold* 8023, 31.iii.1990 (M).

***Neofuscelia squamariatella* Elix, sp. nov.**

Fig. 16

Species *Neofusceliae squamariatae* simili sed ab hac specie thallo tenuiore, erhizinato, lobis angustioribus et superficie inferiore pallido fusca differt.

Type: Australia. Australian Capital Territory: Brindabella Range, summit of Mt. Aggie, 43 km WSW of Canberra, 35°28'S, 148°46'E, 1490 m, on exposed schist rock, *J. A. Elix 11640 & P. W. James*, 21.i.1984; holo: CANB; iso: HO.

Thallus subcrustose, very tightly adnate, saxicolous, 1-6 cm wide. Lobes contiguous to slightly imbricate, flat, irregular, short to sublinear, 0.3-0.8(-1.0) mm wide. *Upper surface* yellowish brown to reddish brown, paler at the lobe apices, dull, or slightly shiny at the lobe apices, smooth, becoming fissured and areolate in thallus centre, lacking soredia and isidia. Medulla white. *Lower surface* dull, not or only obscurely rhizinate, pale tan to brown; lower cortex in part agglutinated directly to substratum. *Apothecia* common, ±immersed when young, becoming sessile or subimmersed, to 0.8 mm wide; disc ±flat, dark brown; thalline exciple entire. *Ascospores* globose to ellipsoidal, 5-7 × 3.5-5.5 µm. *Pycnidia* common. *Conidia* bacilliform, 5-6 × 1 µm.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K+ yellow then red, C-, P+ orange-yellow; containing norstictic acid (major), connorstictic acid (minor), hyposalazinic acid (minor).

Morphologically this species closely resembles *Neofuscelia squamariata* (Nyl.) Essl. in its habit, having very narrow, sublinear to subirregular lobes, and in containing norstictic and connorstictic acids in the medulla. Whereas *N. squamariata* has a jet black lower surface, a thicker thallus and broader lobes (0.5-1.0 mm cf. 0.3-0.5 mm wide), *N. squamariatella* has a pale tan to brown lower surface, thinner thallus and narrower lobes. Further, *N. squamariata* lacks hyposalazinic acid, which is invariably present in *N. squamariatella*. *Neofuscelia squamariatella* appears to be relatively common on exposed alpine and subalpine rocks in southern Australia and New Zealand. It was previously confused with *N. squamariata* because of difficulties in actually observing the lower surface. This is best done by moistening the lobes before trying to remove them from the substrate.

Specimens Examined

AUSTRALIA. Australian Capital Territory: Booroomba Rocks, 11 km SW of Tharwa, 35°33'S, 148°59'E, 1360 m, on exposed granite rocks in subalpine heath, *J. A. Elix 6151*, 11.vii.1979 (CANB); Brindabella Range, summit of Mt Coree, 31 km W of Canberra, 35°18'S, 148°49'E, 1420 m, on exposed rhyolite rocks in subalpine heath, *J. A. Elix 23273*, 22.xi.1989 (CANB). South Australia, Flinders Ranges, Warren Gorge, 18.5 km N of Quorn, 32°11'S, 138°00'E, 400 m, on quartzite rocks in *Eucalyptus camaldulensis* woodland in ravine, *J. A. Elix 17797 & L. H. Elix*, 27.x.1984 (CANB).

NEW ZEALAND. South Island. Otago: Dunstan Mountains, 7 km NE of Lowburn, Central Otago, 220 m, on rocks in open pasture, *J. A. Elix 9736*, 1.i.1982 (CANB). Canterbury: Lake McGregor, on rocks in open pasture, *J. A. Elix*, 20.i.1997 (CANB); Hanmer Springs, along Jack's Pass road, on granite rock in pasture, *J. Johnston 1851*, 11.iii.1985 (CANB).

***Neofuscelia subcrustulosa* Elix, sp. nov.**

Fig. 17

Species *Neofusceliae crustulosae* simili sed ab hac specie thallo tenuiore, erhizinato, lobis angustioribus et acidum 4-*O*-methylhypoprotocetraricum continenti differt.

Type: Australia. South Australia, Mt Lofty Ranges, 13.5 km N of Callington, 5°57'S, 143°10'E, 2660 m, on schist rocks in dry pasture, *J. A. Elix* 9447, 30.x.1981; *holo:* CANB.

Thallus subcrustose, very tightly adnate, saxicolous, 1-6 cm wide. *Lobes* contiguous to slightly imbricate, flat, irregular, short to sublinear, 0.3-0.5 mm wide. *Upper surface* black-brown to reddish brown, dull, paler, smooth, $\pm$ slightly shiny at the lobe apices, becoming fissured and areolate in thallus centre, lacking soredia and isidia. *Medulla* white. *Lower surface* dull, erhizinate, pale tan to brown; lower cortex in part agglutinated directly to substratum. *Apothecia* common, $\pm$ immersed when young, becoming sessile or subimmersed, to 0.8 mm wide; disc $\pm$ flat, dark brown; thalline exciple entire. *Ascospores* subspherical to ellipsoidal, 5.0-6.5 $\times$ 4.0-4.5 μ m. *Pycnidia* common. *Conidia* slightly curved to bacilliform, 6-8.5 $\times$ 1 μ m.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K+ yellow then pale red, C-, P-; containing hypostictic acid (major), hyposalazinic acid (minor), hypoconstictic acid (minor), 4-*O*-methylhypoprotocetraric acid (trace).

Morphologically this species resembles *Neofuscelia crustulosa* (Essl.) Essl. in its habit, having very narrow, sublinear to subirregular lobes and a pale lower surface, and in containing hypostictic, hyposalazinic and hypoconstictic acids in the medulla. However, *N. crustulosa* has a thicker thallus (0.15-0.25 mm *cf.* 0.10-0.12 mm thick) with broader lobes (0.5-1.0 mm *cf.* 0.3-0.5 mm wide) than in *N. subcrustulosa*, adnate apothecia (rather than subimmersed), is sparsely rhizinate (rather than erhizinate) and lacks the 4-*O*-methylhypoprotocetraric acid present in the latter species.

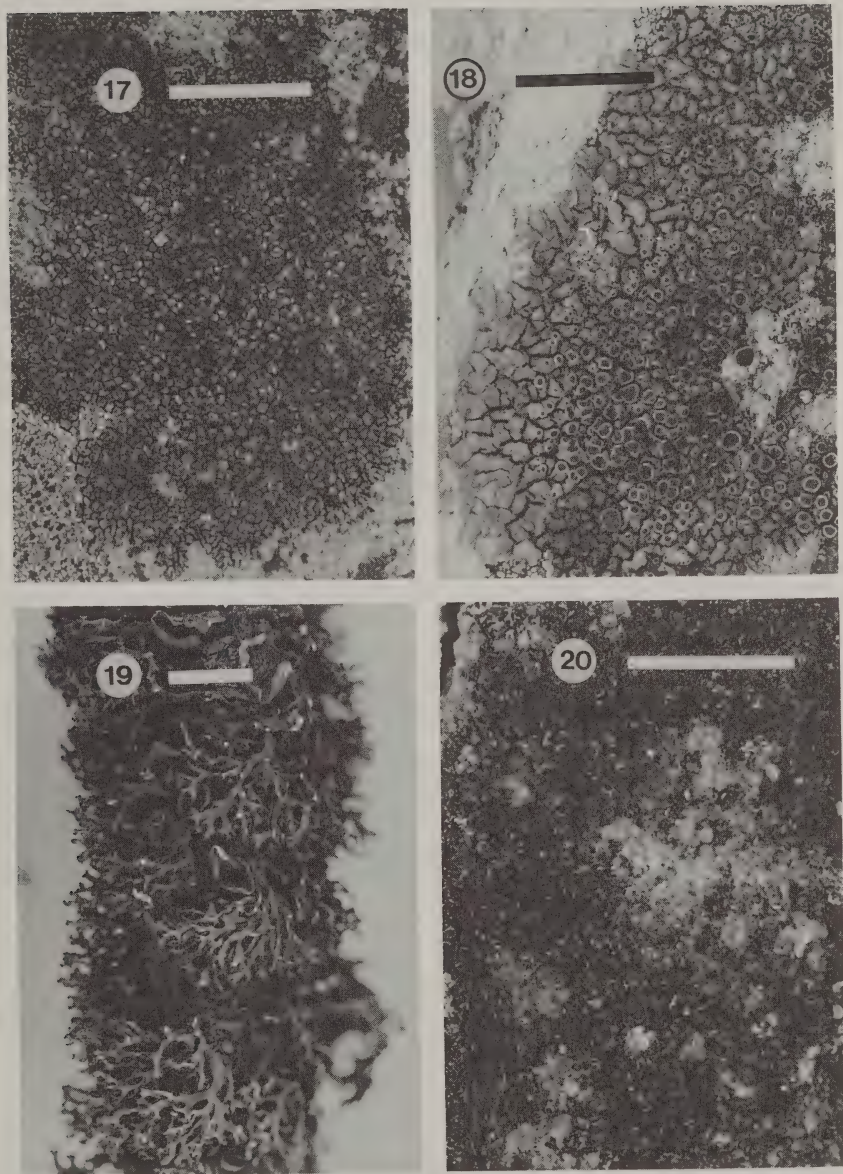
Specimens Examined

AUSTRALIA. South Australia. Type locality, on schist rocks, *J. A. Elix* 9450a, 30.x.1981 (CANB); Flinders Ranges, Stokes Hill Lookout, 15 km NE of Wilpena, 31°25'S, 138°44'E, 650 m, on rocks in open grassland, *J. A. Elix* 17870 & *L. H. Elix*, 28.x.1984 (CANB).

***Neofuscelia subsquamariata* Elix, sp. nov.**

Fig. 18

Thallus ut in *Neofusceliae squamariatae* simili sed superficie inferiore pallido brunnea et acidum caperaticum et acidum norcaperaticum continenti differt.



Figures 17-20. New species of *Neofuscelia*: 17, *N. subcrustulosa* (holotype in CANB); 18, *N. subsquamariata* (holotype in M); 19, *N. torulosa* (holotype in CANB); 20, *N. wesselsii* (holotype in M). Scale bar = 5 mm.

Type: Republic of South Africa. Cape Province: Klein-Swartberge, Droevlei-Seweweekspoort road, 4 km S of crossing Gamkapoortdom, waterfall in gorge opposite picnic ground, 33°23'S, 21°25'E, ca. 900 m, on boulders in gorge, D. Treibel & G. Rambold 7940, 30.iii.1990; holotype: M.

Thallus small foliose to subcrustose, tightly adnate, to 4 cm wide. *Lobes* contiguous, flat to weakly convex, sublinear to subirregular, 0.3-1.0 mm wide. *Upper surface* brown to black-brown, paler at the lobe apices, dull, or slightly shiny at the lobe apices, smooth, becoming fissured and markedly areolate in thallus centre, lacking soredia and isidia. *Medulla* white. *Lower surface* dull or shiny, pale ivory to pale brown, sparsely to moderately rhizinate; rhizines simple, broad or hapteriform, tufted at apices. *Apothecia* common, ±immersed when young, becoming sessile, to 1.0 mm wide; disc ±flat, dark brown; thalline exciple entire. *Ascospores* ellipsoidal, 7-9 × 4-6 µm. *Pycnidia* common. *Conidia* bacilliform to weakly bifusiform, 6-7 × 1 µm.

Chemistry. Cortex K-, HNO₃+ dark blue-green; medulla K+ yellow then red, C-, P+ orange-yellow; containing norstictic acid (major), connorstictic acid (minor), caperatic acid (major), norcaperatic acid (minor).

Morphologically this species closely resembles *Neofuscelia squamariata* (Nyl.) Essl. in habit, having very narrow, sublinear to subirregular lobes, and in containing norstictic and connorstictic acids in the medulla. However, whereas *N. squamariata* has a jet black lower surface, this is pale tan to brown in *N. subsquamariata*. This species also resembles *N. squamariatella* Elix described above, but has a thicker thallus (0.15-0.25 mm cf. 0.10-0.12 mm thick) with broader lobes (0.3-1.0 mm cf. 0.3-0.5 mm wide), adnate apothecia (rather than subimmersed), and is rhizinate (rather than erhizinate). *Neofuscelia subsquamariata* also differs chemically from both *N. squamariata* and *N. squamariatella* in containing caperatic and norcaperatic acids in addition to norstictic and connorstictic acids. At present this new species is known from several locations in Cape Province and Natal in South Africa.

Specimens Examined

REPUBLIC OF SOUTH AFRICA. Cape Province: Cape Province: Type locality, D. Treibel & G. Rambold 7925, 30.iii.1990 (CANB); Waboomsberg summit, 33°38'S, 20°17'E, 1220 m, on boulders and rocks, D. Treibel & G. Rambold 8009, 31.iii.1990 (CANB), D. Treibel & G. Rambold 8005, 8007, 8029, 31.iii.1990 (CANB, M); Leeukop (Lion's Head), W of Cape Town, trail to summit, 33°56'S, 18°23'E, 570 m, on NE-exposed rocks, D. Treibel & G. Rambold 8363, 5.iv.1990 (M). Natal: Royal Natal National Park, hill between Mont-aux-Sources and Chain Ladder, 28°45'S, 28°53'E, ca. 3050 m, on S-exposed rocks, D. Treibel & G. Rambold 7003, 13.iii.1990 (M).

***Neofuscelia torulosa* Elix, sp. nov.**

Fig. 19

Species *Neofusceliae subprolixa* simili sed ab hac specie lobis laciniatis, laciniis subcylindricis et saepe torulosis differt.

Type: Australia. South Australia: Mangalo, 22 km NE of Cleve, Eyre Peninsula, 33° 32'S, 136° 37'E, 270 m, on *Callitris* in remnant *Eucalyptus-Callitris* woodland on flats beside road, J. A. Elix 41825 23 Sep. 1994; holo: CANB; iso: HO, MEL.

Thallus foliose, terricolous, lignicolous or corticolous, moderately to loosely adnate, to 12 cm wide. *Lobes* imbricate, flat or slightly convex at the apices, becoming more strongly convex towards thallus centre, sublinear to subirregular, 1.0-3.5 mm wide, irregularly branched; *lacinae* developing at periphery and within thallus, terete to subterete, $\pm$ torulose, $\pm$ subfruticose, sublinear to linear-elongate, dichotomously to subdichotomously branched, 0.3-1.0 mm wide. *Upper surface* dark brown to black-brown or olive-brown, paler at the thallus periphery, dull to slightly shiny at the apices, smooth or becoming rugose, lacking and isidia. *Medulla* white. *Lower surface* jet black, moderately to densely rhizinate; rhizines black, short, simple or occasionally tufted, slender; *lacinae* canaliculate, pale brown to black with concolorous rhizines. *Apothecia* common, short stipitate, 3-5 mm wide; disc concave, becoming $\pm$ flat or undulate, black-brown; thalline exciple thin, entire, rugose. *Ascospores* 8-9 $\times$ 5-6 μ m. *Pycnidia* common. *Conidia* bifusiform, 6-8 $\times$ 1 μ m.

Chemistry. Cortex K-, HNO₃+ dark blue-green, medulla K-, C-, P-, UV-; containing divaricatic acid (major), nordivaricatic acid (trace), stenosporic acid (minor/trace).

This new species appears to be related to *Neofuscelia pulla* (Ach.) Essl. and *N. subprolixa* Elix since all three species have foliose, nonisidiate thalli with a black lower surface, and may have identical chemistry. However, they can be separated clearly by their morphology. *Neofuscelia pulla* lacks *lacinae* and is adnate to tightly adnate, while the other two species are lacinate and moderately to loosely adnate. Further, the secondary *lacinae* of *N. torulosa* are prominent, distinctly subterete and $\pm$ torulose while those of *N. subprolixa* are rarely prominent and are flat to weakly convex or concave. This new species is quite common in southern Australia where it occurs most commonly on soil but also spreads on to adjacent dead wood and the lower trunk of trees.

Specimens Examined

AUSTRALIA. New South Wales: 3.5 km S of Balranald along the Kyalite road, 34°38'S, 143°34'E, 60 m, on *Casuarina* in scrub, J. A. Elix 4115, 16.xii.1977 (CANB). Victoria: 1 km N of Tallarook, 37°06'S, 145°06'E, on soil in open *Eucalyptus* woodland, J. A. Elix 4885, 29.vii.1978 (CANB). South Australia: 20 km W of Swan Reach, along the Sedan road, 34°34'S, 139°27'E,

80 m, on soil in mallee scrub, *J. A. Elix* 2767, 16.xii.1976 (CANB); 5 km N of Sedan, 34°33'S, 139°18'E, 100 m, on dead wood in mallee scrub, *J. A. Elix* 8769, 30.viii.1980 (CANB); 6 km E of Sedan, 34°34'S, 139°20'E, 80 m, on soil in mallee scrub, *J. A. Elix* 9286, 9293, 9304, 28.x.1981 (CANB); 17 km W of Blanchetown along Hwy. 20, 34°21'S, 139°27'E, 80 m, on soil in mallee scrub, *J. A. Elix* 9278, 28.x.1981 (CANB); 6 km N of Milendella, 34°48'S, 139°12'E, 100 m, on *Callitris* sp. in *Callitris* woodland, *J. A. Elix* 9340, 28.x.1981 (CANB); type locality, on *Callitris*, *J. A. Elix* 41841, 23.ix.1994 (CANB), on soil, *J. A. Elix* 41845, 41848, 23.ix.1994 (CANB).

***Neofuscelia wesselsii* Elix, sp. nov.**

Fig. 20

Thallus ut in *Neofusceliae brussei* simili sed superficie inferiore nigra et acidum lividicum et acidum 4-O-methylphysodicum continenti differt.

Type: Republic of South Africa. Cape Province: Leeukop (Lion's Head), W of Cape Town, NE of summit, 33°56'S, 18°23'E, 669 m, on boulders and rocks, D. Triebel & G. Rambold 8297, 5 April 1990; holotype: M.

Thallus small-foliose to subcrustose, tightly adnate, saxicolous, forming irregular rosettes to 1-2 cm wide, coalescing into larger patches. *Lobes* imbricate or not, irregular to sublinear, subirregularly branched, 0.1-0.5 mm wide. *Upper surface* dark brown to brown-black, flat, smooth and shiny at lobe apices, becoming dull, cracked and areolate in the thallus centre, without isidia. *Medulla* white. *Lower surface* dull, black, erhizinate, lower cortex attached directly to the substratum. *Apothecia* sessile, to 0.8 mm wide; disc ±flat becoming convex, brown-black; thalline exciple entire. *Ascospores* ellipsoidal, 7-9 × 4-5 µm. *Pycnidia* not seen.

Chemistry. Cortex K-, HNO₃+ weak blue-green; medulla K-, C-, P-; containing 4-O-methylphysodic acid (major), lividic acid (major), α-collatolic acid (major), alectoronic acid (trace), physodic acid (trace).

The only other species of *Neofuscelia* known to produce 4-O-methylphysodic acid as the major medullary constituent is the Australian *N. imitatricoides* Elix, a lichen with a much larger, obviously foliose thallus (3-4 cf. 0.5-0.7 cm wide) with broader lobes (0.6-1.2 cf. 0.1-0.5 mm wide) and terete to subterete, unattached laciniae. *N. wesselsii* could be considered the fertile counterpart of the isidiate Australian species, *N. remnantia* Elix, as the two species have similar thalli and medullary chemistries. At present this new species is only known from the type locality. It is named in honour of the South African lichenologist, Dr Dirk Wessels, in recognition of his contributions to the knowledge of the lichens of the region.

New Combination

Neofuscelia subprolixa (Nyl. ex Kremp.) Elix, comb. nov.

Basionym: *Parmelia subprolixa* Nyl. ex Kremp., *Verh. K.-K. Zool.-Bot. Ges. Wien* 30: 337 (1880).

ACKNOWLEDGEMENTS

I thank Drs Dagmar Triebel and Gerhard Rambold (both M), Professor Thomas H Nash III (ASU) and Dr André Aptroot (Baarn) for generously making their excellent collections of Parmeliaceae from southern Africa available to me. I also thank Stuart Hay and Neal McCracken of the Photographic Unit, ANU, for preparing the photographs, Drs Alan Archer and Gintaras Kantvilas for helpful amendments to the draft manuscript, and the following herbaria for the loan of critical collections available: ASU, BM, G, H, HO, M, PRE, S, TUR, W, UPS, US, ZT.

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CULTURAL STUDIES OF NON-POROID APHYLLOPHORALES

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SUMMARY

Cultural descriptions of four wood-inhabiting basidiomycetes, namely: *Phanerochaete septocystidia* (Burt) Erikss. (Corticaceae), *Hyphodermella corrugata* (Fr.) Erikss. & Ryv. (Hyphodermataceae), *Mycobonia flava* (Berk.) Pat. (Mycoboniaceae) and *Steccherinum rawakense* (Pers. apud Gaud.) Banker (Steccherinaceae) are presented. None of these species have been previously described in culture.

Corticium roseum Fr., *Phanerochaete sordida* (Karst.) Erikss. & Ryv. and *Phanerochaete tuberculata* (Karst.) Parm. (Corticaceae) are included here as they exhibit remarkable differences compared with earlier descriptions.

INTRODUCTION

During a systematic study of the wood-rotting fungi from the Province of Misiones, Argentina, several species of *Aphylllophorales* were isolated in culture. The primary objective of this paper is to aid researchers in identifying non poroid *Aphylllophorales* in culture. Macroscopic and microscopic cultural characters of each species on malt extract agar, and growth and reaction on gallic and tannic acids are described.

MATERIAL AND METHODS

Cultures were obtained from mass basidiospore prints or basidiocarp tissue. They were studied and described according to Nobles (1948-1965); plates were grown and maintained in the dark at + 25° C for six weeks. At the end of every week the necessary records and observations were made. Line drawings of microscopic characters were performed with a Wild drawing tube and photographs of 4-5-week-old cultures were taken. Color notations were made in accordance with Maerz and Paul (1930).

The presence of oxidases was determined in 0,5% (w/v) gallic acid agar (GAA) and 0,5% (w/v) tannic acid agar (TAA) (Davidson et al., 1938). Alcohol solution (96°) of 16,6% (w/v) gum guaiac (GG) was used directly on mycelial mats to determine, the presence of oxidases (Nobles, 1958), and its presence or absence recorded as + or -, respectively.

The cultures are deposited in the Spegazzini Institute culture collection. Voucher specimens were deposited at LPS. All Herbarium abbreviations are from Holmgren & Keuken (1974).

CULTURAL STUDIES

Fam. *Corticaceae* Herter

CORTICIUM ROSEUM Fr.

Neues Mag. Bot. 1: 111, 1794.

Thelephora rosea Pers.: Fr., *Syst. Mycol.* 1: 451, 1821.

Laeticorticium roseum (Fr.) Donk., *Fungus* 26: 17, 1956.

Basidiocarp description of this species was given by Eriksson & Ryvarden (1976: 781).

CULTURE STUDIED: N° 164: Argentina: Province of Misiones, Garupá, leg. Ibáñez 60, 17-VII-1991, on decayed wood of Angiospermae= LPS 45049.

GROWTH CHARACTERS: growth very rapid. plates covered in 1st wk. Mats at first white, mostly plumose, developing yellow-cream (Pl.10 J6) from 4th wk on. Margin diffuse. Odor fragrant, like that of flowers, permanent. Reverse changed to honey-like color (Pl.9 F3). Oxidase reaction in GAA: +++, 2.5 cm, in TAA: +++++, 2.5 cm, with GG: +.

MICROSCOPIC CHARACTERS: aerial mycelium formed by generative hyphae with clamp connections, hyaline, staining in phloxine, thin-walled, usually branched, 2.6-3.1 µm wide; in the 2nd wk generative hyphae with thin to irregularly thickened walls, 1-1.5 µm diam.; appear 3rd wk generative hyphae form staining-colored sacciform basidia, 21.3-31.9 x 5.8-6.9 µm diam. It disappear at 5th wk, with absence of spore formation. The cream color of mycelium margin is due to the presence of yellowish incrustated generative hyphae and regular crystals on agar, up to 5.8 µm of side. Inoculum with similar elements to aerial mycelium: generative hyphae 1-5.3 µm wide, basidium formation, incrustated hyphae up to 1 µm wide and regular crystals. Submerged mycelium has similar characters as previous ones.

SPECIES CODE: 2.3.4.8.9.12.13.32.36.38.42.50.54.

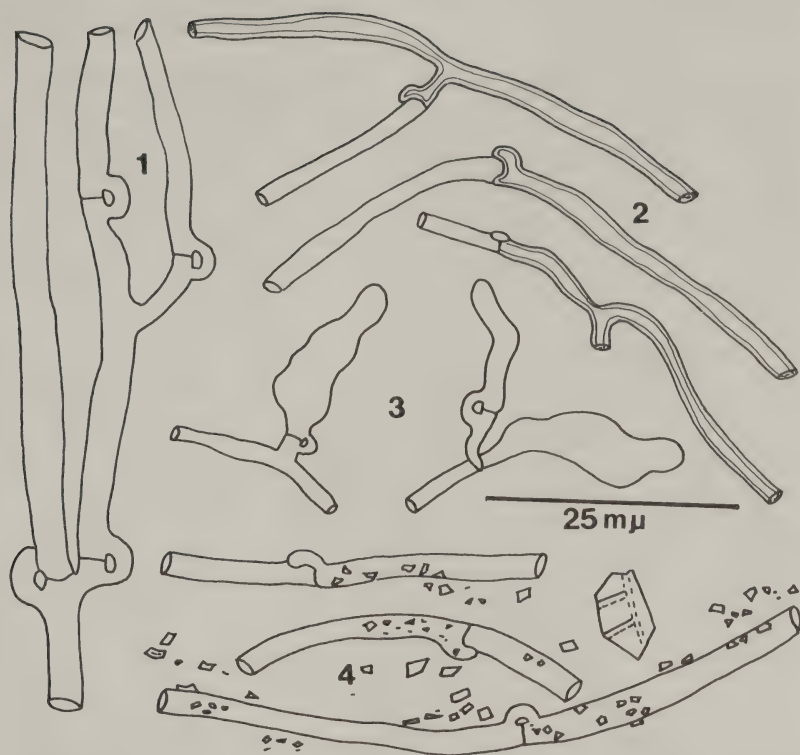


Fig.1-4. Microscopic cultural features of *Corticium roseum*: 1.generative hyphae of the aerial mycelium; 2.sclerified generative hyphae; 3.sacciform basidia; 4.incrusted generative hyphae.

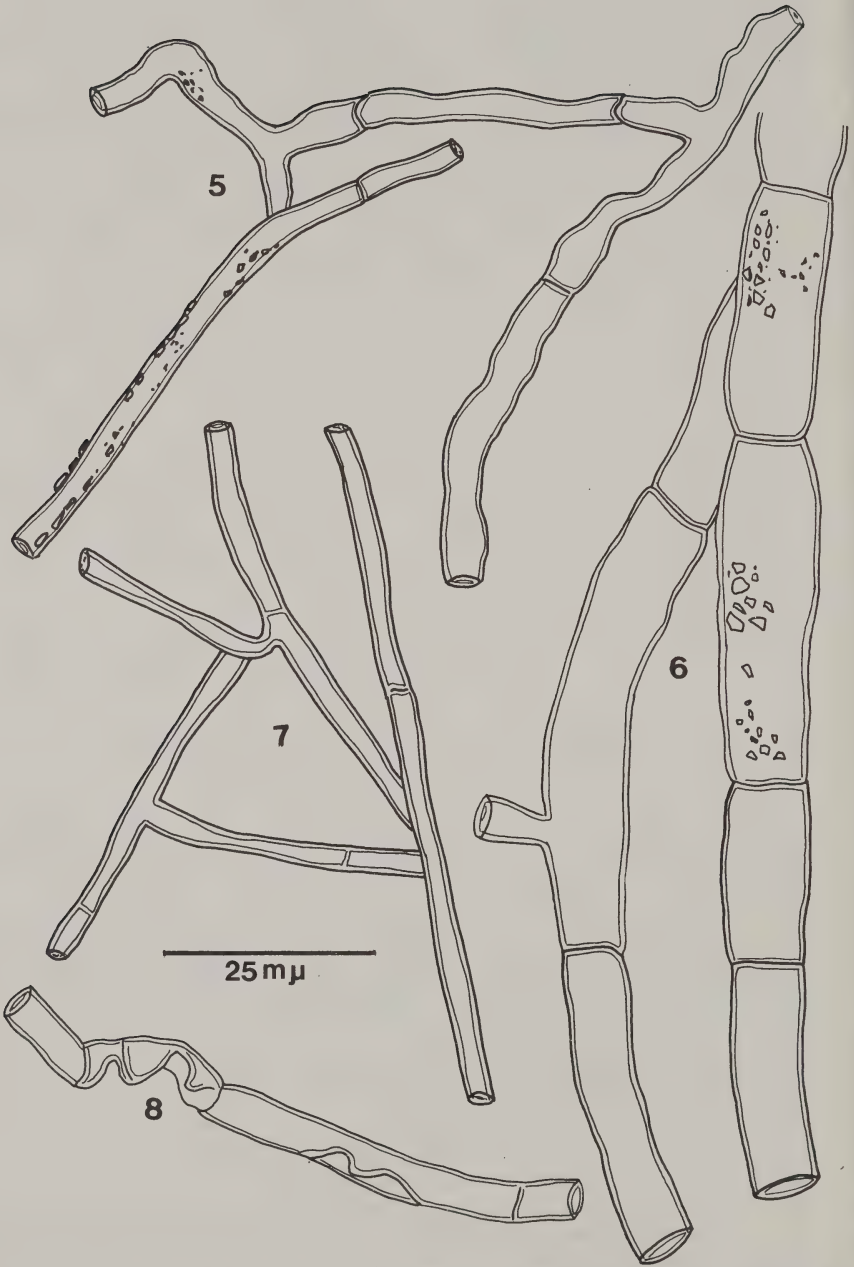
REMARKS: Cultural characteristics for species were described by Stalpers (1978: 143). Incrusted generative hyphae, regular crystals and formation of sacciform basidia were not observed in culture by Stalpers.

PHANEROCHAETE SEPTOCYSTIDIA (Burt) Erikss.

Cort. N. Eur. 5: 1021, 1978.

Peniophora septocystidia Burt, Ann. Miss. Bot. Gard. 12p. 260, 1929.

For basidiocarp description, see Eriksson et al. (1970: 1021).



Figs. 5-8: Microscopic cultural features of *Phanerochaete septocystidia*: 5. incrusted generative hyphae; 6. barrel-like generative hyphae; 7. generative hyphae of inoculum; 8. generative hyphae of the advancing zone.

CULTURE STUDIED: N° 288: Argentina: Province of Misiones, Santa Ana, leg. Ibáñez 70, 19-VII-1991, on unidentified vine= LPS 45051.

GROWTH CHARACTERS: growth rapid, plates covered in 2nd wk. Texture of mats felty, in the advancing zone forming at first white halos toward the inoculum, with yellow margin ("Jasmine" Pl.9 K4), becoming brown-amber ("Burnished Gold" Pl.12 L7, "Antique Gold Golden Y" Pl.12 L8), at the end of the 2nd wk, persistent at the end of the experiment. Margin diffuse. Reverse unchanged. Odor absent. Oxidase reaction in GAA: +++, 3.5 cm, in TAA: ++ without growth, with GG: +.

MICROSCOPIC CHARACTERS: *advancing mycelium* formed by hyaline, branched, 1.5-4.7 μm diam., unclamped generative hyphae; some with "tape-like parts" 3.7-5.3 μm wide; at 2nd wk barrel-like generative hyphae appear, 4.7-8.5 μm diam., and other generative hyphae are thickwalled, thinner, 2.1-3 μm wide; both types are incrustated with crystals. At 3rd-4th wk barrel-like generative hyphae disappear, only thin and sclerified generative hyphae persist. Generative hyphae, 3.7-4.2 μm diam, with walls up to 1 μm ; these hyphal elements are found at the end of 6th wk. *Submerged mycelium*: of similar characters. *Inoculum* with simple septate, branched, yellowish-walled generative hyphae with light-brown to yellowish contents, very thin, 1.5-2.6 μm wide. At 2nd wk brown generative hyphae appear, thicker, some with small crystals on the walls, 1.5-4.8 μm diam.

SPECIES CODE: 2.6.8.12.(14).32.36.37.38.39.42.53.54.

REMARKS: Culture features of this species have not been previously described. Growth rapid, brown-amber colors of mycelium, generative hyphae always simple septate and "barrel-like" generative hyphae, both of them brown and with small crystals on the walls, and sclerified generative hyphae, are characters that permit to differentiate this species in culture.

PHANEROCHAETE SORDIDA (Karst.) Erikss. & Ryv.
Cort. N. Eur. 5: 1023, 1978.

Corticium sordidum Karst., Medd. Soc. F. Fl. fenn. 9: 65, 1882.

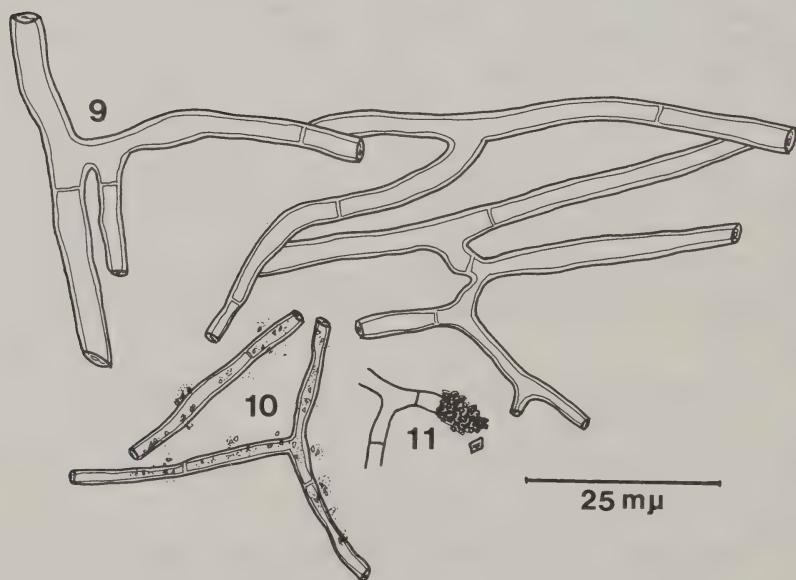
This species has been described by Eriksson et al. (1977: 1023).

CULTURE STUDIED: N° 179: Argentina: Province of Misiones, Santa Ana, leg. Ibáñez 13, 15-I-1991, on trunks of *Nectandra* ssp. (Lauraceae).

GROWTH CHARACTERS: growth moderately rapid, 6.5 cm/7 days, plates covered in 2nd wk. Mats white, cottony, tenuous at first and later adopting a thicker texture toward the inoculum and around all the plate. Margin radiated. Odor absent. Reverse white-yellowish (Pl.9 Cl), darker in the inoculum zone (Pl.9 H4). Oxidase reaction in GAA: +++, 3.5 cm, in TAA: +++, with little growth of 7 mm, in GG: +.

MICROSCOPIC CHARACTERES: aerial mycelium with simple septate, right-angled branches, hyaline, very thin-walled, 3.1-4.7 μ m diam. generative hyphae, these disappear at 2nd wk and are replaced by thinner and less branched, 2.6-3.1 μ m wide hyphae. Inoculum with the same kind of hyphae as the aerial mycelium; at 2nd wk generative hyphae thicker, branched, 3.1-6.3 μ m diam., and at 4th wk incrustated, very thin generative hyphae, 1.5-2 μ m wide and with crystals up to 5.3 μ m of side. Submerged mycelium formed by similar hyphae, tortuous branched, 2.6-5.3 μ m diam.

SPECIES CODE: 2.6.7.12.(34).36.40.42.53.57.



Figs.9-11: Microscopic cultural features of *Phanerochaete sordida*: 9.generative hyphae of the aerial mycelium; 10.generative hyphae of the inoculum; 11.incrusted generative hyphae.

REMARKS: growth and microscopic features coincide with those given by Nakasone (1990: 244), but chlamydospores and generative hyphae with double or multiple clamps were not found in our culture.

PHANEROCHAETE TUBERCULATA (P. Karst.) Parm.
Consp. Syst. Cort. p. 83, 1968.

Corticium tuberculatum Karst., *Hedw.* 35: 45, 1896.

Basidiocarp description of this species was given by Eriksson et al. (1978: 1033).

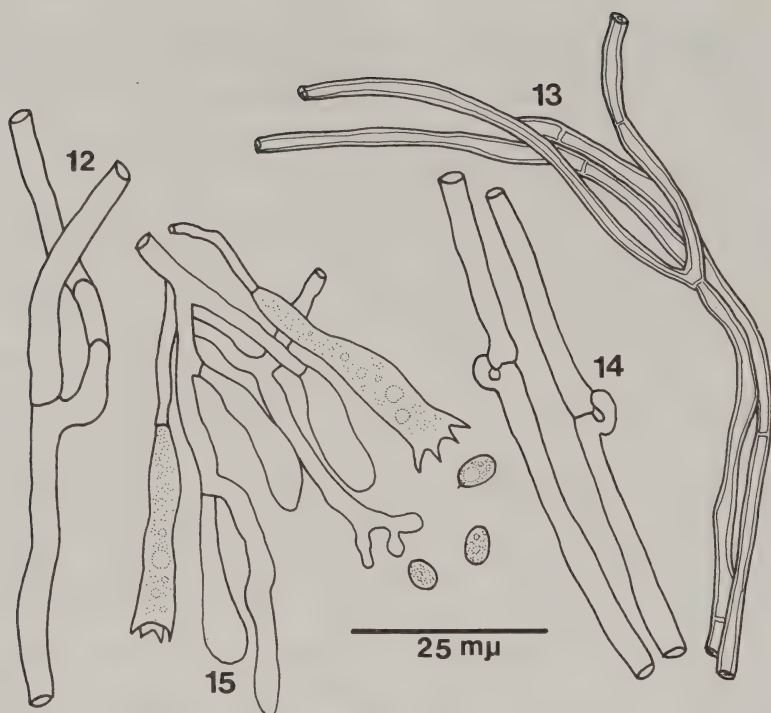
CULTURE STUDIED: N° 435: Argentina: Province of Misiones, Santa Ana, leg. Ibáñez 30, 14-III-1991, on stump= LPS 45071.

GROWTH CHARACTERS: mats of fast growth, covering the plate in 1st wk. Submerged mycelium, chamois-like, white-yellowish ("New Silver" Pl.11 B1), radiated, becoming farinaceous at 5th wk. Odor none. Margin diffuse. Reverse unchanged. *Oxidase reaction*, in GAA: -, with growth of 3.5 cm, in TAA: -, without growth, with GG: -.

MICROSCOPIC CHARACTERS: *inoculum* of simple-septate, yellowish, 1.4-7.2 μm diam., generative hyphae, crystals formed by 2nd wk. In the 3rd wk simple-septate hyaline generative hyphae appear, staining in phloxine, with secondary septa and vacuolized contents, formed the 4th wk basidium, 11.5-25.4 μm wide. *Aerial mycelium* with simple-septate, yellowish, generative hyphae, some more brownish than inoculum, up to 2.4 μm diam. In the 3rd wk brownish yellowish-walled, generative hyphae appear, mainly simple-septate but with occasional single clamp connections, up to 3.4 μm diam.; formation of 4-sterigmato, urniform or clavate basidia, with basal septa, 19.2-25 x 3.4-5.3 μm diam., hyphidium up to 3 μm wide and ellipsoid, thin-walled, smooth, hyaline spores, with oily plasmatic contents, 4-5.8 x 3-3.4 μm diam. *Submerged mycelium* with similar brownish, generative hyphae in aerial mycelium and very abundant crystals in the 1st wk. In the 2nd wk simple-septate generative hyphae with secondary septa, up to 7.2 μm wide, staying at the end of study.

SPECIES CODE: 1.5.6.8.12.32.37.38.41.48.53.

REMARKS: This study reveals important cultural differences from those given by Stalpers (1978: 172). Yellow-brownish generative hyphae, crystals and formation of the basidiocarp before the end of 6th wk are characters not observed previously.



Figs.12-15: Microscopic cultural features of *Phanerochaete tuberculata*: 12.yellowish generative hyphae of the inoculum; 13.generative hyphae of the aerial mycelium; 14.generative hyphae with clamp connections of the aerial mycelium; 15.basidium, hyphidium and ellipsoid spores with oily plasmatic contents.

Fam. *Hyphodermataceae* Jülich

HYPHODERMELLA CORRUGATA (Fr.) Erikss. & Ryv.
The Cort. of North Eur. Vol. 4, 1976.

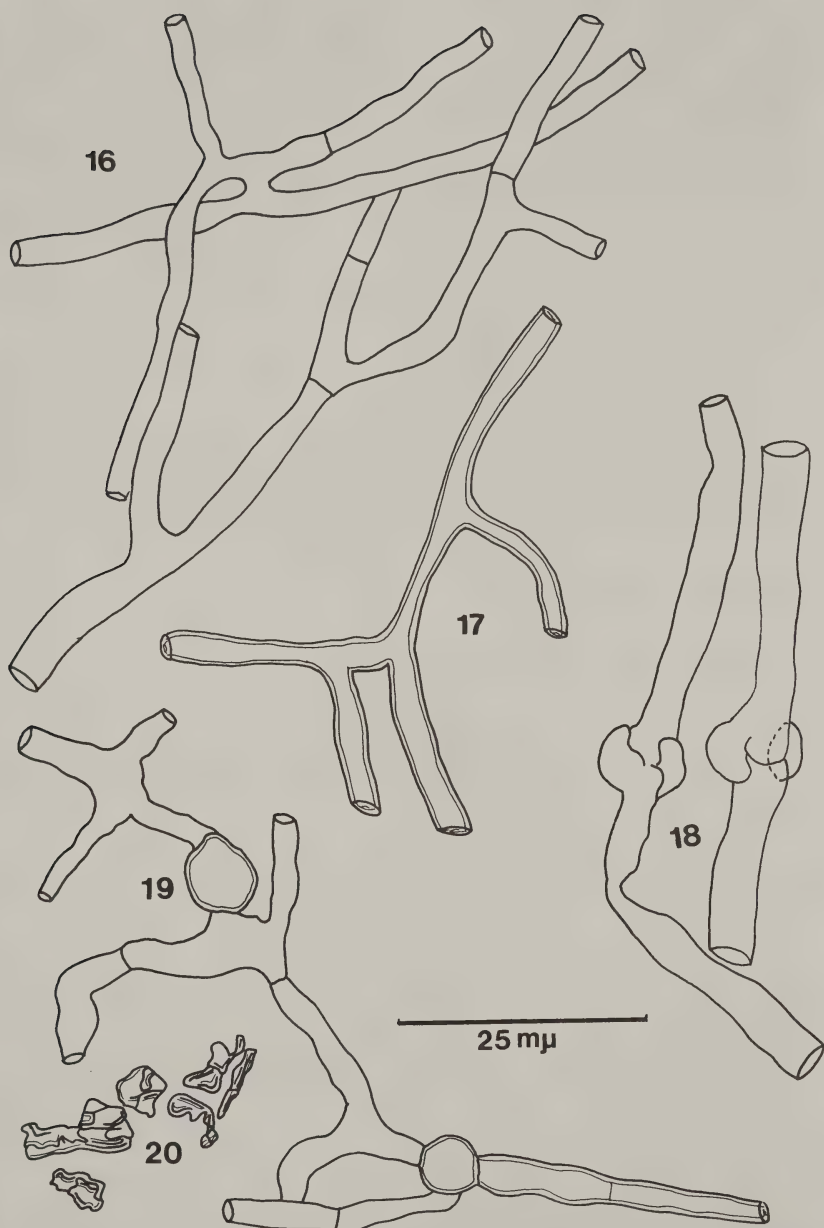
Grandinia corrugata Fr. *Hym. Eur.* p.625, 1874.

Odontia corrugata (Fr.) Bourd. & Galz., *Bull. Soc. Mycol. France* 30 p., 1914.

This species has been described by Erikss. & Ryv.(1976: 579).

CULTURE STUDIED: N° 434: Argentina: Province of Misiones, Santa Ana, leg. Ibáñez 173, 28-IV-1993= LPS 45288.

GROWTH CHARACTERS: growth very rapid, covering the plate in the 1st wk. Mats white, submerged, chamois-like. Odor none. *Margin* diffuse. Reverse unchanged at the beginning of growth, bleaching at 5th wk. *Oxidase reaction*, in GAA: -, 7 cm, in TAA: -, without growth, with GG: -.



Figs. 16-20. Microscopic cultural features of *Hyphodermella corrugata*: 16. generative hyphae of the inoculum; 17. fiber hyphae of the submerged mycelium; 18. generative hyphae with multiple clamps; 19. chlamydospores; 20. crystals of the inoculum.

MICROSCOPIC CHARACTERES: *inoculum* of unclamped, hyaline, not staining in phloxine, 2-5 μm diam. generative hyphae and crystals at 4th wk, up to 12 μm of side. *Aerial mycelium* with generative hyphae similar to *inoculum*, 0.9-5.6 μm diam., staining hyphae with swellings, up to 10 μm wide; these hyphae disappearing in the last wk. *Submerged mycelium* formed by similar generative hyphae and fiber hyphae up to 2.4 μm in the 1st wks., some generative hyphae with occasional multiple clamp connections, 3.8-4.3 μm diam., they disappear later. At 3rd wk vacuolized, intensely staining generative hyphae, constitute spherical chlamydospores, 5.3-8.6 x 5-8.2 μm diam., of which only few persist at 6th wk.

SPECIES CODE: 1.5.8.(26). 34.36.40.41.53.

REMARKS: cultural features of this species have not been previously recorded. Mats white, chamois-like, fast growing, simple-septate generative hyphae with occasional multiple clamps, crystals, fiber hyphae and spherical chlamydospores are diagnostic characteres of this species in culture.

Fam. *Mycoboniaceae* Jülich

MYCOBONIA FLAVA (Berk.) Pat.

Bull. Soc. Myc. Fr. 10: 77, 1894.

Hydnum flavum Berk. Ann. Mag. Nat. Hist. I 10: 380, 1842.

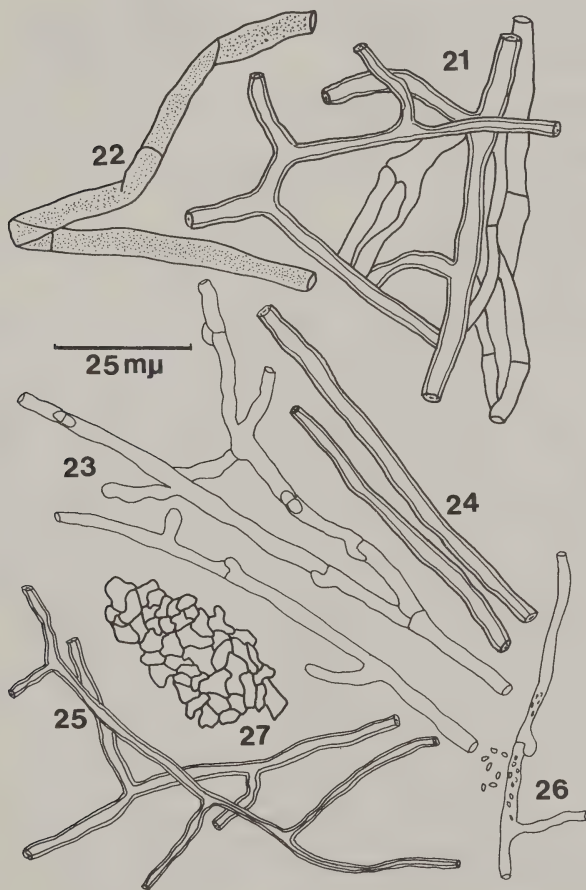
Description of fruitbodies of this species was given by Martin (1939: 247-249).

CULTURE STUDIED: N° 339: Argentina: Province of Misiones, Santa Ana, leg. Ibáñez 146, 14-I-1993, on decayed wood= LPS 45262.

GROWTH CHARACTERS: *mycelium* of moderate growth, 6-7-5 cm/14 days, covering the plate in the 3rd wk. Mats white, woolly at the beginning of growth, in by 2nd wk plumose in the center and arachnoid in the margin, with formation of brown, farinaceous *mycelium* and white cottony *mycelium* in the last wk. *Margin* diffuse at the beginning of the experiment, later bayed. *Odor* sweet, persistent. *Reverse* unchanged and fairly bleached in the last wk. *Oxidase reaction*, in GAA: +, without growth, in TAA: ++, with little growth, with GG: +.

MICROSCOPIC CHARACTERES: *aerial mycelium* formed by simple clamped, thin-walled, hyaline, non-staining, 1.9-2.8 μm wide generative hyphae, fiber hyphae hyaline, more branched, 0.4-2.4 μm diam. in the 3rd wk and ovoid to ellipsoid arthrospores, smooth, hyaline, 1-1.9 x 0.4-0.9 μm diam., only

few in the last wk. *Inoculum* with same generative hyphae as the aerial mycelium, but thicker, $1.9-7.2\ \mu\text{m}$ wide, few fiber hyphae of similar diam. by 4th wk and simple clamped, brown generative hyphae, $2.4-3\ \mu\text{m}$ diam., form a pseudoparenchyma of cuticular cells that produce the brown farinaceous mycelium. *Submerged mycelium* formed by similar clamped, generative hyphae, occasionally simple-septate, $2.4-3.5\ \mu\text{m}$ wide, few unbranched, hyaline, yellowish-walled, $1.8-2.4\ \mu\text{m}$ diam. fiber hyphae.



Figs. 21-27: Microscopic cultural features of *Mycobonia flava*: 21.hyphae of inoculum; 22.generative hyphae of aerial mycelium; 23.simple clamped generative hyphae of aerial mycelium; 24.fiber hyphae of submerged mycelium; 25.fiber hyphae of inoculum; 26.arthrospores; 27.pseudoparenchyma.

SPECIES CODE: 2.3.(4).8.10.33.36.37.38.(40).43.50.54.

REMARKS: Cultural features of this species have not yet been recorded. White, cottony mats with formation of brown farinaceous areas, sweet odors, hyaline simple clamped generative hyphae, hyaline fiber hyphae and brown hyphae differentiated to form a pseudoparenchyma, are diagnostic characters of this species in culture.

Fam. *Steccherinaceae* Parm.

STECCHERINUM RAWAKENSE (Pers. apud Gaud.) Banker
Mycologia 4: 312, 1912.

Hydnum rawakense Pers. apud Gaud. *Freycin. Bot. Voy. Monde*: 175, 1827.

Mycoleptodon rawakensis (Pers. apud Gaud.) Pat. in *Essai tax. Hym.*: 117, 1900.

Basidiocarp description of this species was given by Maas Geesteranus (1974: 523).

CULTURE STUDIED: N° 28: Argentina: Province of Misiones, Santa Ana, leg. Ibáñez 119, 22-VII-1992, on decayed wood= LPS 45095.

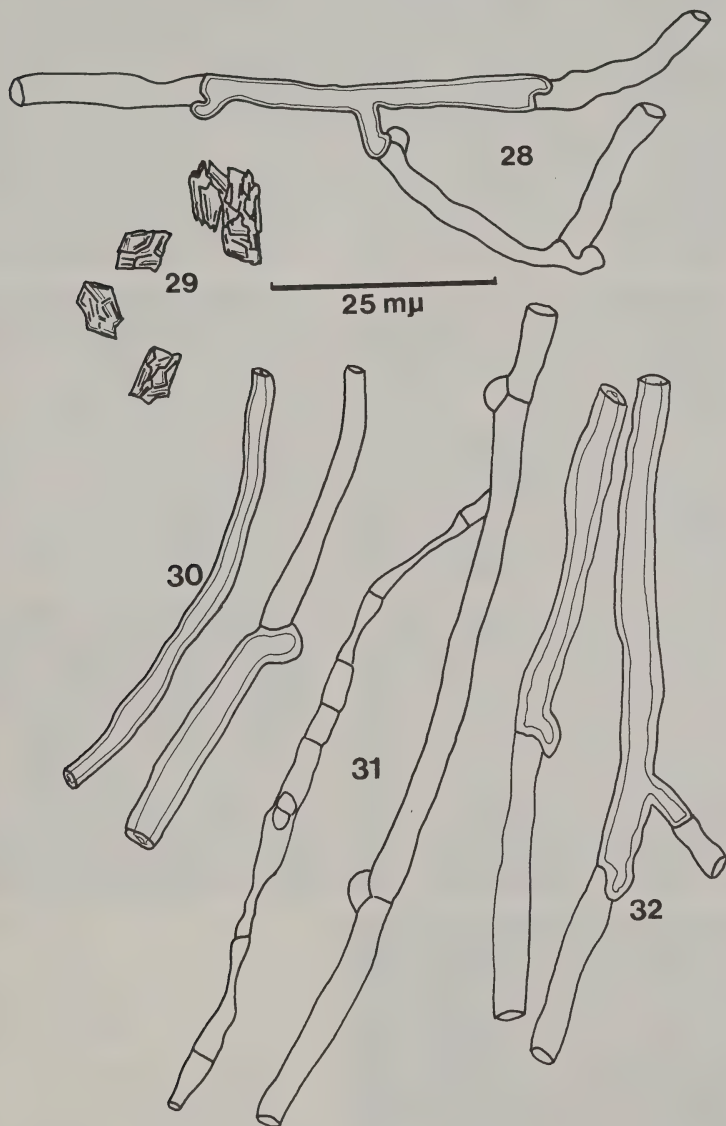
GROWTH CHARACTERS: mycelium of moderate to slow growth, 4-6 cm/14 days, covering the plates in 3rd-4th wks. Mats whitish-yellow ("Amber-white" Pl.11 C1), plumose, submerged. Margin diffuse. Odor sweet, almond-like. Reverse unchanged, bleaching in the 2nd wk. *Oxidase reaction* in GAA: +++++, without growth, in TAA: +++++, little growth, with GG: +.

MICROSCOPIC CHARACTERS: *inoculum* formed by simple clamped, thin-walled, hyaline, more branched, 2.1-5.3 μ m diam. generative hyphae and regular and amorphous crystals in the 1st wk. These elements persistent to 3rd wk and are replaced by sclerified generative hyphae, 2.6-3.7 μ m diam. and thin, hyaline, up to 2.6 μ m diam. fiber hyphae. These four elements persist up to the last wk. *Advancing mycelium* with simple clamped, thin-walled hyaline, very thin and branched, 2.6-4.7 μ m diam. generative hyphae. In the 5th wk generative hyphae with more secondary septa and sclerified generative hyphae, 2.1-4.3 μ m; formation of fiber hyphae not seen. *Submerged mycelium* with similar characters to the above mentioned.

SPECIES CODE: 2.3.4.8.9.32.36.40.43.44.50.54.

REMARKS: Cultural characters of this species have not been previously recorded. Diagnostic characters are: mats whitish-yellow, plumose and submerged, almond-like persistent odor,

simple clamped generative hyphae of two kinds: a) thin-walled and b) sclerified, presence of fiber hyphae and abundant crystals.



Figs.28-32: Microscopic cultural features of *Steccherinum rawakense*: 28.sclerified generative hyphae; 29.crystals; 30.fiber hyphae; 31.generative hyphae of advancing mycelium; 32.sclerified generative hyphae of advancing mycelium.

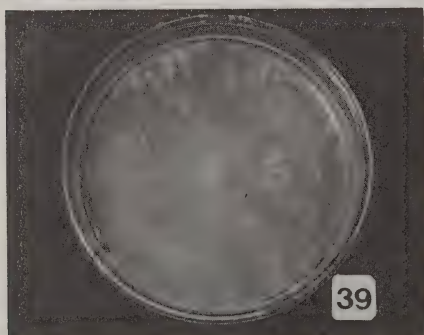
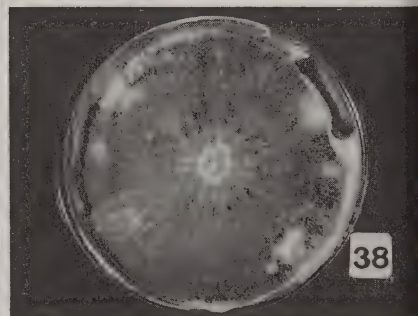
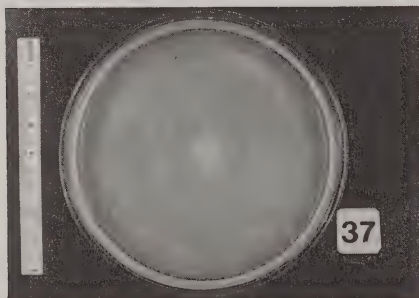
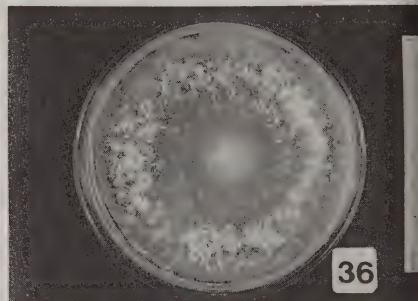
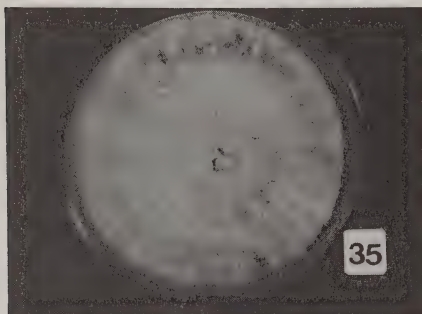
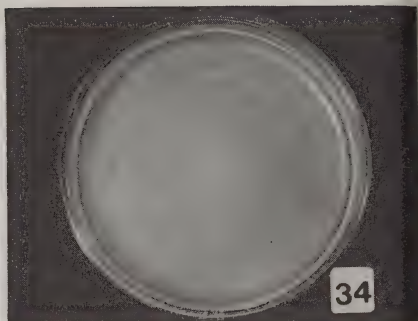
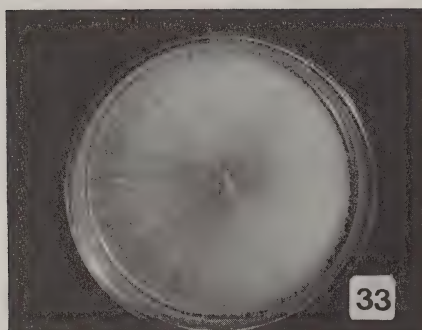


Fig.33-39: Macroscopic aspects of mats in culture (4-5 wk old) of:

33. *Corticium roseum*;

34. *Phanerochaete septocystidia*.

35. *Phanerochaete sordida*;

36. *Phanerochaete tuberculata*;

37. *Hyphodermella corrugata*;

38. *Mycobonia flava*;

39. *Steccherinum rawakense*.

ACKNOWLEDGMENTS

The author thanks to Dr. Jorge E. Wright (University of Buenos Aires) and Dr. Leif Ryvarden (University of Oslo), for their critical review of the manuscript; and Mr. Guillermo Rothsche for the photographic work presented in this paper.

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MYCOTAXON

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SOME LOCULOASCOMYCETE SPECIES FROM THE GREAT BASIN, USA

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ABSTRACT

Some Loculoascomycetes that develop in plants of the Great Basin region of western USA are described as new: *Achaetobotrys latispora*, *Protoventuria nevadensis*, and *Diademosia foliicola*. *Leptosphaeria cercocarpi* is transferred to *Dothideopsella*.

A number of interesting collections were made by the second author on his rambles throughout the Great Basin area of Utah, Nevada, and eastern California, USA. These he sent to the first author for confirmation of their status in the Loculoascomycetes. Three of them are new to science, whereas the fourth had been described early in this century and is relocated to a more appropriate genus.

CAPNODIALES: ANTENNULARIELLACEAE

A superficial epiphyte on dead leaves of *Cercocarpus ledifolius* Nuttall in Torr. & A. Gray (Rosaceae) forms patches composed of characteristic dark, moniliform hyphae that bear a layer of small, glabrous ascomata with rather sooty aspect. This fungus fits well in *Achaetobotrys* Bat. & Cif., rather than *Antennulariella* Woron., where hyphal appendages develop over ascomata (Hughes 1976). *Achaetobotrys* was described and previously known (Batista and Ciferri 1963) only from tropical regions (Australia and Puerto Rico). Two additional species, not yet described, are also known from southwestern USA. The present species is named for the ascospores that are considerably wider than in the other taxa. Minute pycnidia were not found in the collection, although such structures are known in other species.

Achaetobotrys latispora M.E. Barr & Rogerson, sp. nov.

Fig. 1, a-d

Ascomata gregaria superficialia glabra parva globosa 100-150 μm diametro, exorientes crusta superficialis cellulis moniliformibus. Asci bitunicati fissitunicati saccati 25-32 x 14 μm . Hamathecium nullum. Ascosporae 10-14 x 5-6 μm brunneae uniseptatae obovoideae. Holotypus epiphyticus super foliis veteribus *Cercocarpus ledifolii* "USA: Nevada: Mineral Co., Wassuk Range, 1.7 miles north of Corey Peak Road from Lucky Boy Pass Road, 12 Jun 1994" a C.T. Rogerson lectus in NY depositus.

Forming black, superficial, crustose patches composed of rows of moniliform cells, with protruding short hyphae and knots of a few cells; cells mostly 5-6 μm diam, globose except for constraint by adjacent cells, brown, smooth or occasionally verruculose. Ascomata globose, small, 100-150 μm diam, gregarious on and arising from hyphal layer, glabrous; apex rounded, pore minute, lysigenous; peridium narrow, ca. two rows of pseudoparenchymatous cells, 6-10 μm wide. Asci few, bitunicate, fissitunicate, basal, saccate, 25-32 x 14 μm . Hamathecium lacking. Ascospores 10-14 x 5-6 μm , brown, hyaline when young, obovoid, uniseptate, ends obtuse; wall thickened, smooth; crowded in the ascus.

Epiphytic over old dead leaves of *Cercocarpus ledifolius*, known only from the type collection.

PLEOSPORALES: VENTURIACEAE

A setose species belonging to the Venturiaceae developed in a sparse subiculum on blackened blotches formed by compact hyphae in overwintered stems of *Paeonia brownii* Douglas ex Hook. (Paeoniaceae). Only a few loculoascomycetous taxa have been reported on this host plant. Müller and Ahmad (1955) described *Euryachora paeoniae* E. Müll. & S. Ahmad from Pakistan. Shaw (1973) reported *E. stellariae* [= *Omphalospora stellariae* (Lib.) Theiss. & Syd.] from Washington. Both genera produce stromata and form paraphysate asci in small locules, and are assigned to the Dothideaceae (Barr 1987) or to the Mycosphaerellaceae (Hawksworth et al. 1995).

In the Venturiaceae both superficial subiculum and immersed hyphae are known in only three genera having uniloculate ascomata. Species of *Acantharia* Theiss. & Syd. form setae on subiculum as well as on ascomata, produce a hyphomycetous anamorph (Sivanesan 1984a), and have relatively large, dark brown ascospores. *Metacoleroa dickiei* (Berk. & Broome) Petr., the sole species in the genus, forms a subcuticular layer, rarely extending deep into the leafy substrate (Corlett and Kokko 1978), and a well developed superficial subiculum. [*Coleroa* (Fr.) Rabenh. differs from *Metacoleroa* in the absence of superficial subiculum.] Species of *Protoventuria* Berl. & Sacc. develop intramatrical hyphae that may lie deep in

host tissues, and a slight or well developed superficial subiculum. This genus seems best suited to house the new taxon. Barr's (1989b) key to species should be amended to include the present species. *Protoventuria arizonica* M.E. Barr on *Cercocarpus* evidently is most closely related to the species described below, but differs in forming few apical setae and in obtusely ended ascospores.

Protoventuria nevadensis M.E. Barr & Rogerson, sp. nov.

Fig. 1, e-h

Ascomata superficialia supra maculae nigrescentes vel 10 x 5 mm, ascomata ovoidea 100-125 μ m lata 125-140 μ m alta, setae nigrobrunneae aseptatae (40-)45-50(-70) μ m longae, peridia brunnea angusta 12-15 μ m lata pseudoparenchymata. Asci bitunicati fissitunicati oblongi vel inflati basali 50-75 x 12-15 μ m. Pseudoparaphyses angustae cellularis. Ascospores 15-18 x 6-7 μ m dilutae olivaceae brunneae obovoideae fusoidae acutae uniseptatae submedianae foveolatae. Holotypus in caulibus emortuis *Paeoniae brownei* Douglas ex Hook. "Nevada: Humboldt Co., Humboldt National Forest, Santa Rosa Mountains, Lyle Camp-ground Road, 9 Jun 1996," a C.T. Rogerson lectus in NY depositus.

Blackened blotches 10 x 5 mm, composed of three to four rows of compact, cuboid, brown cells, in epidermis and deeper in tissues to 50 μ m, melanized droplets visible deep in stem tissues; ascomata superficial in thin subiculum on blotches, ovoid, 100-125 μ m wide, 125-140 μ m high, ostiole minute, lysigenous; setae numerous over most of peridium, dark brown, (40-)45-50(-70) μ m long, aseptate, arising from dark enlarged base ca. 10 μ m wide, tapering to point; peridium lighter brown, pseudoparenchymatous, 12-15 μ m wide. Asci bitunicate, fissitunicate, basal, 50-75 x 12-15 μ m. Pseudoparaphyses narrowly cellular. Ascospores 15-18 x 6-7 μ m, light olivaceous brown, obovoid fusoid, uniseptate submedian, constricted at septum, upper cell 9-11 μ m long, lower cell 6-7 μ m long and slightly narrower; wall delicately foveolate; contents granular; overlapping biseriate in the ascus.

In overwintered stems of *Paeonia brownei*, known only from the type collection.

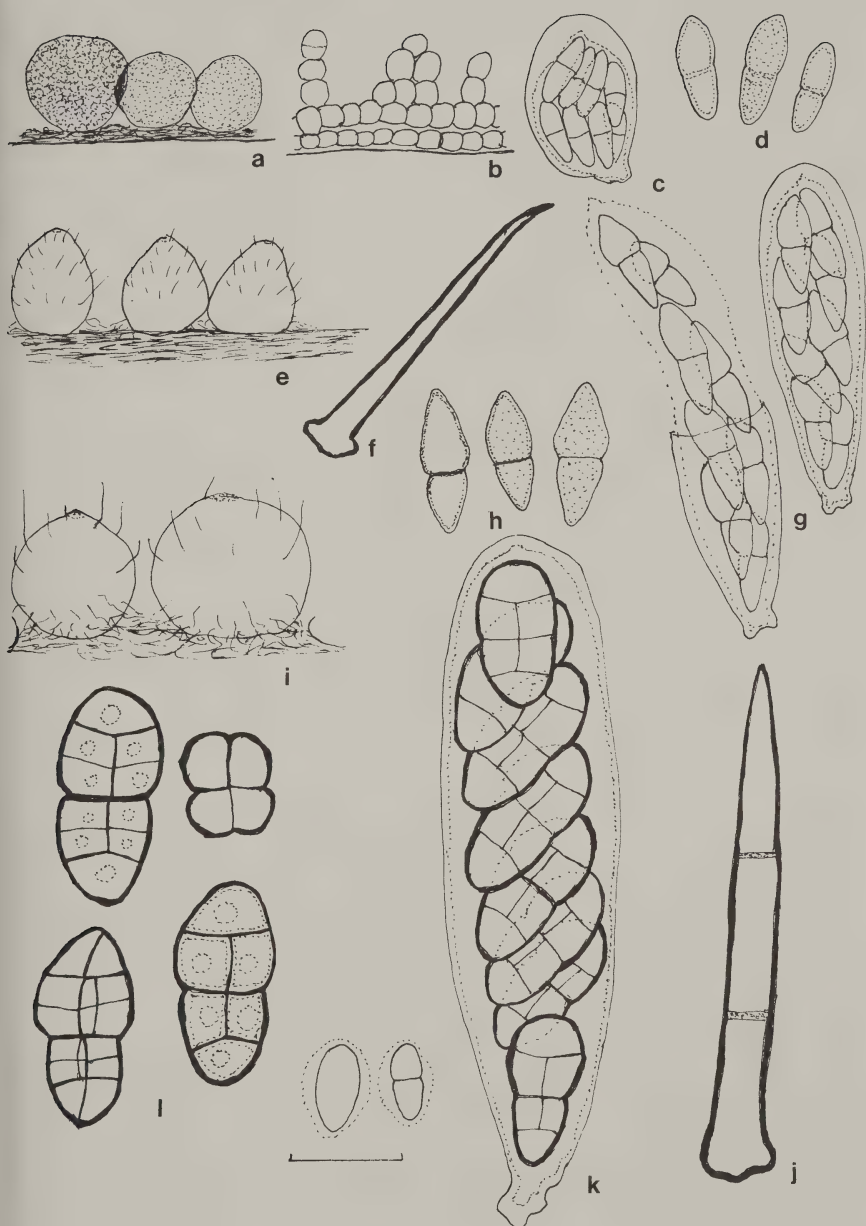
PLEOSPORALES: DIADEMACEAE

Another setose species forms widely erumpent to superficial, grouped ascomata with a reduced hyphal hypostroma, among trichomes in coriaceous leaves of *Cercocarpus ledifolius*. At first viewing the species seemed suggestive of the Venturiaceae, but it differs especially in producing strongly pigmented, thick-walled dictyospores. Most dictyosporous Loculoascomycetes are either immersed erumpent in herbaceous tissues or develop in or on woody substrates. With a combination of superficial, setose ascomata and dictyospores, this taxon was compared

to the description and illustrations of *Pleotrichiella australiensis* Sivan., described as hypophyllous on leaves of *Lasiopetalum ferrugineum* Sm. (Sterculiaceae) in Australia (Sivanesan 1984b). The superficial ascomata of that fungus have a stout, three-layered peridium and differently shaped ascospores uniseriate in cylindric asci. No relationship is apparent between it and the present species. Another pleosporalean taxon that produces superficial, setose ascomata and dictyospores is *Pleospora delicatula* (Vestergren) Wehm. The ascomata develop in and around leaf trichomes of *Cerastium tomentosum* L. (Caryophyllaceae). According to descriptions and illustrations (Wehmeyer 1961, Crivelli 1983), this probably is a species of *Nematostoma* Syd. & P. Syd. in the Pseudoperisporiaceae (Barr 1997). Müller (1965) described as a form of *Pleospora tragacanthae* Rabenh. a somewhat similar but larger taxon that developed among trichomes in dead leaves of *Potentilla cinerea* L. (Rosaceae). Crivelli (1983) restricted that species to *Astragalus*, *Oxytropis* and perhaps other Fabaceae; he did not treat Müller's collection that may well be related to the present fungus. The detour suggested by possible names in *Pleospora* Rabenh. ex Ces. & DeNot. led only to *P. penicillus* (Fr.) Fuckel, but the ascospores of that fungus are thin walled and lightly pigmented.

Species that develop in herbaceous tissues and have heavily pigmented, thick-walled ascospores in broad asci are diagnostic of taxa in the Diademaceae Shoemaker & C.E. Babc. 1992. A revised concept of that family was proposed (Barr in Eriksson and Hawksworth 1993) and additional information is in preparation. Shoemaker and Babcock (1992) had restricted the family to species that open by an apical lid. Such a feature occurs elsewhere, in genera such as *Wettsteinina* Höhn. (Shoemaker and Babcock 1987), where approximately one half of the species that these authors accepted open by an apical lid, the rest by a lysigenous pore. In Barr's revised concept, terete or applanate condition and ascospore septation separate the genera; asymmetry or symmetry in shape and/or septation of ascospores is a subgeneric or specific character. In this fashion, the taxon in leaves of *Cercocarpus* belongs in *Diademosa* Shoemaker & C.E. Babc. 1992. Most of the

Fig. 1. Loculoascomycetes from the Great Basin. a-d. *Achaetobotrys latispora*: a, ascomata in side view; b, portion of hyphal layer and protruding cells; c, ascus; d, ascospores. e-h. *Protoventuria nevadensis*: e, ascomata over intramatrical hyphae; f, seta from surface of ascoma; g, two asci, that on left illustrating fissitunicate opening; h, ascospores. i-l. *Diademosa foliicola*: i, two ascomata in side view; j, seta from surface of ascoma; k, ascus; l, ascospores, upper right in end view, lower right two ascospore initials in gel coating. Standard line = 150 μ m for a, g, i, 15 μ m for other figures.



species to be assigned there have asymmetric ascospores with differently shaped and septate hemispores. The taxon in question is one of few known at present in the genus that forms quite symmetric ascospores whose hemispores are nearly equal in shape and septation.

Diademosa foliicola M.E. Barr & Rogerson, sp. nov. Fig. 1, i-l

Ascomata superficialia gregaria hypophylla globosa 150-200 μm lata 200-250 μm alta, ostiola lysigena, setae numerosae nigro-brunneae septatae 35-150(-170) μm longae (4-)5-8 μm latae basali, peridia brunnea pseudoparenchymata vel 25 μm lata. Asci bitunicati fissitunicati basali oblongi vel clavati 85-125 x 20-25 μm . Pseudoparaphyses cellulosae 4-5 μm latae. Ascosporae (18-)22-25(-30) x 10-13(-15) μm brunneae obovoideae vel ellipsoideae obtusae, transversaliter 3-5-septatae longitudinaliter 1-2-septatae. Holotypus in foliis caducii *Cercocarpil edifolii*, "California: Mono Co., White Mountains, 14 Jul 1994," a C.T. Rogerson lectus in NY depositus.

Ascomata superficial in small groups from a sparse, immersed, hyphal hypostroma, usually hypophyllous, nearly globose, 150-200 μm wide, 200-250 μm high, apex obtuse, ostiole minute, lysigenous; setae numerous, dark brown, septate, 35-150(-170) μm long, tapered from (4-)5-8 μm at base to pointed apex; peridium pseudoparenchymatous, two to three rows of brown cells, up to 25 μm wide. Asci bitunicate, fissitunicate, basal, oblong, 85-125 x 20-25 μm , mostly 8-spored, occasionally 4- or 6-spored. Pseudoparaphyses cellular, 4-5 μm wide, cells short. Ascospores (18-)22-25(-30) x 10-13(-15) μm , rich brown, obovoid ellipsoid, ends obtusely rounded, 3-5-septate with two longitudinal septa (one visible in most views) at right angles in mid cells and often into end cells; wall thick, smooth; one globule per cell; biseriate in the ascus.

Common in dead leaves of *Cercocarpus ledifolius*. Additional collections examined: (all collected C.T. Rogerson and deposited in NY) NEVADA: Elko Co.: Pequop Mts., summit exit of Interstate 80, 1 Jul 1991; E. side Duckwater Peak, Currant Mts., 24 Aug 1991; White Pine Co.: Hampton Creek trailhead to Mt. Moriah, 28 Aug 1991; Nye Co.: Toiyabe Range, Toiyabe Nat'l Forest, Northumberland Canyon, 7.8 mi. W. of Monitor Valley, 18 Jun 1994; Clark Co.: Toiyabe Nat'l Forest, east side of Spring Mts., Forest Route 157, Fletcher Canyon Trailhead, 5.7 mi NW Forest Boundary, 12 May 1995; White Pine Co.: E. side Snake Range, Snake Creek Canyon, 24 Jun 1995; Lexington Trail end, 25 Jun 1995; Elko Co.: Lamoille Canyon, Humboldt Nat'l Forest, 13 Jul 1996. UTAH: Washington Co.: Dixie Nat'l Forest, Oak Grove Campground, 24 Jun 1992; Beaver Co. E side Mineral Mts., 4.9 mi. W of Beaver, 24 May 1996.

Only infrequently were asci seen containing immature ascospores (Fig. 1, l lower right.) In general all

ascospores within an ascoma appeared to be mature. Synchronous maturation is a condition commonly found in members of the Diademaceae.

The fungus in culture (CTR 94-45) produced a knot of hyphae from one or more cells of each ascospore. Hyphae penetrated the agar but did not spread laterally. This species is homothallic. Each knot produced one ascoma identical to those on the leaf. No anamorph was formed.

PLEOSPORALES: BOTRYOSPHAERIACEAE

The fungus known as *Leptosphaeria cercocarpi* Syd. & P. Syd. is present on several of the collections that house *Diademosia foliicola*. The species has been of interest to us for some years because of its incongruity in *Leptosphaeria* Ces. & DeNot. The species was well described and illustrated by Shoemaker (1984) and Huhndorf (1992), from the type collection (Utah: Salt Lake Co., Mill Creek Canyon, 22 Jun 1905, O.A. Garrett 677, S). Its habitat in coriaceous leaves, the globose ascomata with short apex and stout, large-celled peridium, and the wide, light brown ascospores biseriate in broadly oblong asci all deviate from these features in *Leptosphaeria*. The search for an acceptable genus was resolved by the publication of a redescription and illustrations of *Dothideopsella agminalis* (Sacc. & Morthier) Höhn., the type species of that genus (Ahn and Shearer 1998). Although that species is considerably larger in all respects, it shows the diagnostic features seen in *Leptosphaeria cercocarpi*, which point to disposition in the Botryosphaeriaceae. Incidentally, the phragmosporous species that Barr (1989a) had assigned to *Dothidotthia* Höhn. are also well accommodated in *Dothideopsella*, leaving *Dothidotthia* as a related genus to include only the didymosporous taxa.

Dothideopsella cercocarpi (Syd. & P. Syd.) M.E. Barr & Rogerson, comb. nov.

Basionym: *Leptosphaeria cercocarpi* Syd. & P. Syd., Ann. Mycol. 5: 339. 1907.

Additional collections are documented below and are deposited in NY. All collections were made by C.T. Rogerson unless otherwise stated. Utah: Bryce Canyon Nat'l Park, 21 Aug 1973, M.E. Barr 6152. Beaver Co., East side Mineral Mountains, 24 May 1996 (with *Diademosia foliicola*). Nevada: White Pine Co., East side of Snake Range, Snake Creek Canyon, 24 Jun 1995. White Pine Co., Humboldt Nat'l Forest, Currant Mountain, 24 Aug 1991 (with *D. foliicola*). Clark Co.: Toiyabe Nat'l Forest, East side Spring Mountain, 12 May 1995 (with *D. foliicola*). California: Modoc Co., Modoc Nat'l Forest, SE side of Warner Mountains, 8 Jun 1996.

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INTERCONTINENTAL INTERRELATIONSHIPS AMONG DISJUNCT POPULATIONS OF MELANOTUS (STROPHARIACEAE, AGARICALES).

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ABSTRACT

Based on morphology and sexual compatibility the following names in *Melanotus* appear to represent a single species: *M. textilis*, (type locality Vancouver, Canada), *M. proteus*, (type locality South Africa), and *M. horizontalis*, (type locality France). Widespread presence of pleurocystidia is reported.

Key words: *Melanotus*, mating systems, biogeographical distribution.

INTRODUCTION

We have investigated several disjunct populations of small, crepidotoid agarics and determined the basidiomata to be assignable to *Melanotus* Pat. based upon taxonomic keys by Horak (1977), Singer (1986) and Watling and Gregory (1987). Collections determined to be *M. textilis* Redhead & Kroeger were gathered along the Pacific coast of North America, and in Scotland *M. proteus* (Kalchbr.) Sing. and *M. horizontalis* (Bull.:Fr) Orton were collected.

Traditionally the majority of *Melanotus* species have been delineated by micromorphology and substratum (Horak, 1977). Watling and Gregory (1987) separated *M. horizontalis* from *M. proteus* mainly by spore dimensions, pileipellis architecture, and by substratum, with *M. horizontalis* on deciduous wood, and *M. proteus* on coniferous wood (*Cupressus*, *Picea*). Redhead and Kroeger (1984) and Redhead (1989) reported *M. textilis* as occurring on rotting fabrics and woody logs. Specimens of all three taxa reported here fruit predominantly on native and introduced wood.

MATERIALS AND METHODS

Morphotaxonomy:

Basidiomata of 47 collections were examined to assess micromorphological characters. Descriptive terminologies are based on those by Largent (1986), Largent and Baroni (1988), Largent *et al.* (1977) and Singer (1986). The use of cresyl blue according to the methods outlined by Kühner (1934) was found to be invaluable in elucidation of the gelatinized areas of the pileipellis.

The pleurocystidia of many examined basidiomata were difficult to discern unless certain steps were undertaken in the preparation of lamellar sections. Sections must be under 15 micrometers thick, and entire tangential sections must be cleanly cut. Sections were deposited in distilled water and thin sections were identified under a

stereo microscope at 100-300x. Once sections were chosen, they were placed in a drop of de-ionized water on a microscope slide. Bibulous paper was used as a wick to draw off basidiospores adhering to the hymenial surface, while de-ionized water was added to the aid in the wicking process. Finally, ammonium hydroxide (10%) was added, a cover slip placed over the sections and the mount viewed under 400x in phase contrast. Pleurocystidia were noted by the tips of their emergent necks.

Collections examined: CANADA: British Columbia, Vancouver, on fabric of discarded furniture, 9.VII.82, P. Kroeger (DAOM 188219, HOLOTYPE of *M. textilis*); Vancouver, U. B. C., Endowment Lands, on bark and exposed wood of dead *Sambucus racemosa* var. *arborescens*, 22.IX.82, P. Kroeger (DAOM 197018); Vancouver, U. B. C., on rotting stems of *Rubus ursinus* Cham & Schlecht, 1.XI.82, P. Kroeger (DAOM 188216); Vancouver, U. B. C., on bark and wood at base *Sambucus racemosa* L., 23.VII.82, P. Kroeger (DAOM 188217); Vancouver, U. B. C., Endowment Lands, on dead *Sambucus racemosa* bark, 8.VIII.83, P. Kroeger, (DAOM 197019); Saturna I., Gulf Is., on rotting floor boards in house, 19.V.83, P. Kroeger (DAOM 188218); Saturna I., on rotting carpets in vegetable garden, 17.IX.83, P. Kroeger (DAOM 190556); Saturna I., Mt. Warburton Pike, fabric of discarded couch, 17.VIII.83, P. Kroeger (DAOM 190554); Saturna I., Gulf Is., on rotting carpet by road, 8.VIII.82, P. Kroeger, (DAOM 188214); Neavey Lake, in Stanley Park, 14.VIII.82, P. Kroeger (DAOM 188215); Cliff Gilker Park, Roberts Creek, on discarded blue jeans, 1.X.83, P. Kroeger (DAOM 190555); North of Hope, on hardwood bark, 14.X.73, J. E. and S. A. Redhead (DAOM 188213); West end, bottom of woven split-bamboo chair, 21.VI.84, P. Kroeger (DAOM 190553); SOUTH AFRICA: in ligno humido, fabrefacto, clathrato, vitifero, hortensi prope Somerset-East, Promont: bonae spei. Kalchbrenner, Jan. 1876, Leg. P. MacOwan; Exsic. no. 503, ISOTYPE of *M. proteus* (FH), (DAOM). UNITED KINGDOM: England, Swinley, Windsor Forest, on dead branch of *Salix*, 26.II.94, M. Ainsworth, W310 (E 00037825); Rochdale, Smallshaw Wood, 6.X.89, P. Hill (E 00037826); Essex, Monks Wood, Epping Forest, on Beech stump, 10.X.82, Martin Gregory, Orton 5316 (E 00037827, EPITYPE of *M. horizontalis*); Yorkshire, Braham Park, on wood, 9. IX.83, R. Evans, Orton 5450 (E 00037828); Yorkshire, The Snake, on fallen branch, 22.X.94, P. Booth (E 00037829); Berkshire, Brick Pits near Ascot, on *Betula*, M. Ainsworth, 4. IIX.93, W251 (E 00037830); Tandle Hill Park, on fallen branch of beech, 4.X.92, P. Hill (E 00037832); Devon, on beech, 20.I.91, P. Roberts, (E 00037833); Scotland, Rork Garden, on wood, 5.X.92, M. Dickson (E 00037831). Scotland, vic. Pitlochry, Kindrogen, on *Betula*, 31.VIII.97, R. H. Petersen 6964 (TENN 56287 Scotland, vic. Pitlochry, Kindrogen, on *Picea*, 31.VIII.97, Martyn Ainsworth 6963 (TENN 56288); vic. Pitlochry, Kindrogen, on conifer logs, 5.IX.97, R. H. Petersen 3862 (TENN 56290). FRANCE: Forêt d'Amainvilliers, sin petite souchre non déterminie, sous *Picea*, 27.XII.97, P. A. Moreau (PC 97112701). UNITED STATES: California, Humboldt Co., Big Lagoon, Duck Hunters Parking lot area, N of LP road, on branch of *Alnus rubra* Bong. 27.X.1991, M. Moser and D.L. Largent, DLL9152 (HSU 11667); Trinidad, Stagecoach Dr., Waters residence, on log ends of *Pinus muricata* D. Don. 10.XI.86, V. Waters, BLT571 (HSU 10233); Trinidad, Patricks Point State Park, on log of *Picea sitchensis* (Bongard) Carr., 19.X.86, V. Waters, VW 62 (HSU 10278); Trinidad, Big Lagoon school nature trail, on twigs of *Picea sitchensis*, 20.IV.95, DS74 (TENN 54930); Trinidad, Patricks Point Drive, on log and branches of *Sequoia sempervirens* Bong., 10.XI.95, DS104 (TENN 54935); Trinidad, 1 mile N Chevron station, on twigs, 10.I.96, DS102 (TENN 54936); McKinleyville, Clam Beach, on stems of *Lupinus arboreus* Sims, 9.II.73, Tim Baroni,

NBR 1059 (HSU 996); McKinleyville, Murray Rd. Spruce forest, on log of *Alnus rubra*, 29.X.77, D. L. Largent, DLL7503 (HSU 5921); Orick, Gold Bluff Beach area, on twigs, 5.XI.94, DS69 (TENN 54931); Orick, Holter Ridge bike trail, on branches of *Ceanothus foliosus* Parry, 3.X.94, DS80 (TENN 54932); Orick, Lost Man Creek area, on *Ceanothus foliosus*, 16.X.93, DS35 (TENN 54933); Orick, Davison Road, on branches of *Alnus rubra*, 20.XI.93, DS62 (TENN 54934); Orick, Prairie Creek State Park, Davison Rd., on twigs of *Alnus rubra*, 23.VII.94, DS60 (TENN 54938); Orick, Big Hill Rd., on branches of *Ceanothus foliosus*, 27.II.94, DS61 (TENN 54939); Samoa, Samoa Dunes, 100 feet to W of road entering gun club, on branches of *Lupinus arboreus*, 20.XII.94, DS79 (TENN 54937); Arcata bottoms, near Nature Conservancy, on branches of *Lupinus arboreus*, 20.XI.94, DS100 (TENN 54977). Arcata, Janes Rd., Steele residence, on towel, 20.VIII.93, Ken Steele, DS06 (HSU 10200); Mendocino Co., Van Damme State Park, on hardwood, 24.XII.91., Glen Walker, GRW 34. Washington, on cut end of log, 23.VIII.92, S. A. Redhead, L. Norvell (DAOM 225302); King Co., Seattle, U. W., on hardwood, 4.X.92, Glen Walker 5734 (TENN 52573); Pierce Co., Mount Rainier National Forest, 16.X.96, H. Miller, on hardwood limb (OKM 26749).

Isolation of single-basidiospore isolates (SBIs) followed the protocol by Gordon and Petersen (1991). All cultures and pairings were grown on malt extract (Difco, 1.5%) agar (Difco-Bacto, 2.0%). DAPI (4', 6-Diamidino-2-phenylindole dihydrochloride), a cationic fluorescent dye that specifically binds to adenine-thymine-rich DNA was used to stain nuclei. Nuclei were routinely stained to ascertain the karyotic state of cultures when evidence of clamp connection formation was ambiguous. In order to assess genetic relationships among the three putative taxa, four randomly chosen SBIs from each of ten collections used in this analysis were crossed in all possible combinations ($n = 16$, Table 1).

Table. 1.

Compatibility grid of ten *Melanotus* collections

	3	6	6	9	8	8	7	5	G	2
	8	9	9	0	5	5	3	7	R	6
	6	6	6	3	6	6	1	3	W	7
	2	3	4	7	0	1	9	4	3	4
								4	4	9
3862		+	+	+	+	+	+	+	+	+
6963			+	+	+	+	+	+	+	+
6964				+	+	+	+	+	+	+
9037					+	+	+	+	+	+
8560						+	+	+	+	+
8561							<+	+	<+	+
7319								+	<+	+
5734									+	+
GRW34										+
26749										

+ = total compatibility (16:16); <+ = partial compatibility (>10:16)

RESULTS

Morphological observations:

Basidiomata of all examined collections exhibited embedded and/or emergent pleurocystidia, often with membrane-bound, apical droplets. In all collections a gelatinized layer was found directly below the pileipellis. It appears that hyphal walls in this tissue exude mucus but do not gelatinize, as they remain distinct. By utilizing a cresyl blue/ethanol/xylol rinse the mucus could be observed.

Since all collections examined (see below) were found to conform to the same range of measurements and architecture, the following inclusive micromorphological description can be offered:

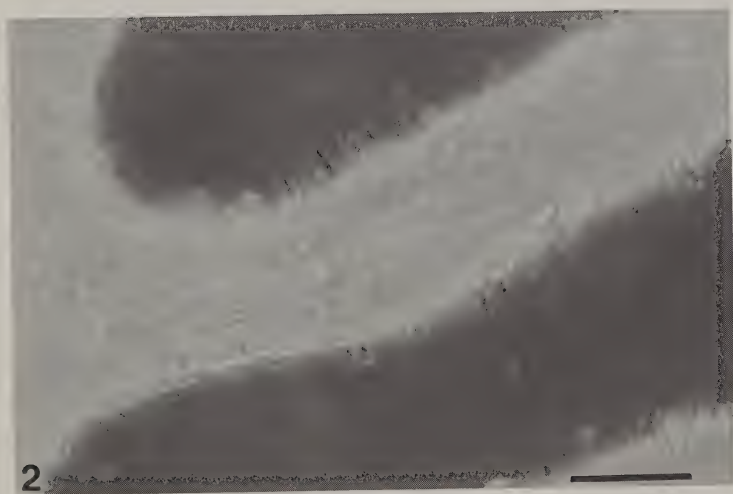
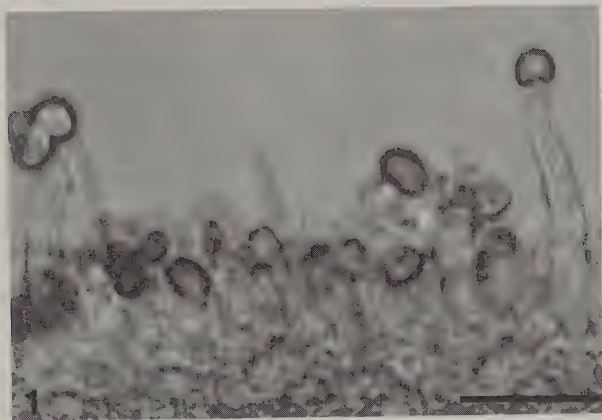
Spores 6.4-7.2 (-8) x 4-5 μ m, ($\wedge$ L 6.9; $\wedge$ W 4.2; Q = 1.61; n = 40), in profile elliptical to subamygdaliform, with an apical germ pore, in mass brown-vinaceous. Wall up to 1.0 μ m thick, smooth, spores violet in NH₄OH under bright field. Basidia 17-24 x 5-7 μ m, cylindrical to clavate, often constricted subapically, thin-walled, 4-spored, hyaline. Cheilocystidia 15-30 (-33) x 4-5 μ m, numerous, clavate, lageniform to ventricose-rostrate; neck often wavy; apex narrowing, thin-walled, often with a membrane-bound, hydrophobic golden drop up to 7 μ m diam. Pleurocystidia (Fig. 1) 17-30 (-35) x 4-5 μ m, numerous to scattered, always embedded but with an emergent neck, similar in shape to cheilocystidia, often with apical droplet (Fig. 1). Caulocystidia abundant, lageniform to vesiculose, often highly contorted but otherwise similar to cheilocystidia and pleurocystidia, with apical droplet. Hyphae of stipe trama strictly parallel, 6-17 μ m diam, hyphal walls <2 μ m thick; hyphae of central trama interwoven, 2-5 μ m diam, hyphal walls <1 μ m thick. Lamellar trama parallel to interwoven; hyphae 7-13 μ m diam; hyphal walls <1 μ m thick. Subhymenium paranchymatic; individual cells up to 22 μ m wide. Pileipellis a lattice; seated on a gelatinized zone up to 20 μ m deep; hyphal walls distinct but producing a mucus; disc area with individual erect, filiform tips up to 64 x 2 μ m, occasionally terminating in branched processes; outward pileus surface a lattice of loosely interwoven hyphae; hyphae 5-7.5 μ m diam, with golden spiral encrusting pigments in NH₄OH; occasional terminal elements filiform, thin-walled, 2.0-3.0 μ m diam, emanating from pellicle hyphae. Pileal trama radially interwoven; hyphae up to 5.0 μ m diam, thick-walled (walls up to 2 μ m thick).

Intercollection matings:

All intercollection crosses were completely intercompatible, with the exception of 8560 x 7319; 8561 x GRW34; 7319 x GRW34 (Table 1). In the latter matings no less than ten pairings per intercollection cross were found to be intercompatible. Excised mycelia from contact zones of all intercompatible crosses grew vigorously and formed abundant clamp connections.

DISCUSSION

According to several authors (Table 2), the three putative taxa of *Melanotus* discussed here are separable based on several macro- and micromorphological characters; but specimens under all three names (including type specimens; see above) were found to exhibit similar micromorphological features. We have determined that there is much overlap in the characters traditionally used to segregate these three morphospecies and we refer all of the examined specimens to the priorable name *Agaricus* (*Melanotus*)



Figs. 1-2. Pleurocystidia of *Melanotus textilis* (9037).

1. Pleurocystidia with apical drop. Scale = 10 μ m. 2. Pleurocystidia. Scale = 25 μ m.

Table 2.
Circumscription of *Melanotus* taxa by various authors.

Taxon	Author	Spore size (lwx) profile
<i>Melanotus textilis</i>	Redhead & Kroeger. (1984)	6-7 (-7.5) x 3.5-4.5um, ovoid and only slightly compressed, smooth, relatively thin-walled, (<0.5 µm) (8.5 x 6 on 72 spored basidia).
	Watling & Gregory (1987)	6-6.7 (-7.2) / 4.4- 5 um, ovate, yellow-brown, smooth, relatively thin-walled, germ pore and apiculus distinct.
<i>M. horizontalis</i>	Reijnders and Vallaga (1992) (as <i>Phaeomarasmius</i>)	6-7.5 (8)x (3.5)4-5 um, in vooraanzicht ellipsoid en iets breder, dikwandig, licht geelbruin in ammonia, met kiempore en moeilijk zichtbare apiculus. Q=1.35-1.8 gem. Q= 1.45 -1.6
	Watling & Gregory (1987)	5-7/3.5-4.5 um, not or barely lentiform, ellipsoid or ellipsoid ovoid in both views.
	Orton (1984)	5-7/3.5-4.5 um.
	Wilhelm, (1998)	6-6.5 (7) x 4.5-5 um, ovoïdes a un peu amygdaliiformes, lisses, a parfois un peu epaissies; nettement dextrinoides dans le Melzer, caractere bien visible sur sporee, pore germinatif. absent ou aussi bien visible: apicule difficilement observable, un peu emousee au bout, dimensions assez constantes. (see above for mesures).
<i>M. proteus</i>	Watling & Gregory (1987)	6-7 x 4-4.5 um, broadly ellipsoid-amygdaliiform in side view, ellipsoid or ovoid in face-view, distinctly thick-walled.
	Horak (1977)	(5)-6-7.5x 4-5 um.
	Pegler (1977)	5-7 x 4-5.5 um, lenticular, subglobose to broadly ellipsoid in face view, ellipsoid in side-view. (6.5 x 4.7 x 4).
	Pegler (1986)	5.5-7.5 x 4.5-5.7 um, lenticular, broadly ovoid to almost subglobose in face view, ellipsoid in side view. (6+/-0.3 x 5 +/-0.3 x 4.2+/-0.2, Q=1.41
	Reid (1975)	5.75-6.5 x 4.0-4.2, lenticular, with thick brown, smooth walls, and apical germ pore.
	Pilat (1950)	7-8 (8.5) x 5-5.6 um, ellipsoïdeae, fuscae tinctu purpureo-violaceo, poro germinativo conspecto munitae et apiculo basali vix visibilibi praeditae, laeves.
	E. Kits Van Waveran (1979)	5.9-6.8 x 4.1-4.5 um, ellipsoid-amygdaliiform, smooth, pale brown in 10% ammonia, distinctly thick walled, w/ a small apical germ pore.

Table 2. (cont'd.)
Circumscription of *Melanotus* taxa by various authors.

Taxon	Author	Chelocystidia	Substratum
<i>Melanotus textilis</i>	Redhead & Kroeger. (1984)	15-26 x 4.5-5 um	Rotting fabric, textiles.
	Watling & Gregory (1987)	21-25x 5.5-6 um	Doormat.
<i>M. horizontalis</i>	Reijnders and Vellinga (1992)	16-33x 3-6 um	Hardwood.
	(as <i>Phaeomarasmius</i>)		
	Watling & Gregory (1987)	24-32x 4-6 um	Fagus, rotting deciduous logs.
	Orton (1984)	24-32 x 5-6 um	Hardwood.
	Wilhelm, (1998)	20-40 x 5-8 um	Hardwood.
<i>M. proteus</i>	Watling & Gregory (1987)	17.6-25.6x 4.8-6.4 um	Conifer wood.
	Horak (1977)	14-28x 3.5-5.5 um	Conifer wood.
	Pegler (1977)	14-28 x 3.5-5.5 um	Cupressus, various wood.
	Pegler (1986)	14-22 x 4-6 um	Dead twig.
	Reid (1975)	not seen	In ligno humido, fabrefacto, clathrato, vitifero, hortensi prope Somerset -East.
	Pilat (1950)	not provided	Same as above.
	E. Kits Van Waveran (1979)	17.6-25.6 x 4.8-6.4um	Coniferous stump.

horizontalis Bull.:Fr. Fries's (1821) implicit sanction of the name is found on page 24 of his *Index Alphabeticus* to *Systema Mycologicum*, Vol. 3.

The morphotaxon *M. horizontalis* was implicitly iconotyped by Orton (1984: 596) using J. B. F. Bulliard's (1787-88) plate 324. In plate 324 (reconstructed as Fig. 3) the mushrooms in the lower right/upper left corner are rather centrally stipitate, but the stipe is distinctly curved. In addition, in the habitat figure the lamellae appear distant. While this is not typical of *Melanotus*, it is difficult to suggest other generic affinities based solely on this illustration. Bulliard described the pileal surface as "glabre." Habitat is listed as "on le trouve sur l'ecorce des poiriers, il y a des arbres don't le tronc en est garni depuis la naissance des grosse branches jusque vers la terre." (caption to pl. 324; *Agaricus horizontalis*). Orton (1960) also furnished a discussion of synonymy. Of four specimens labelled as *Agaricus (Naucoria) horizontalis* from PC (none linked to Bulliard), we determined that three were *Phaeomarasmium rimulincola* (Rab.) Orton which has a pileal surface covered with floccons and small squamules, while the fourth was a *Melanotus* taxon, labelled as *M. horizontalis*.



Fig. 3. Reproduction of Bulliard plate 324. Modified to fit page dimensions.

Orton (1960) linked Bulliard's plate to an Orton specimen, and we propose that the specimen on which Orton (1984) based his transfer of *A. horizontalis* to *Melanotus* be designated as epitype, with Bulliard's plate a putative lectotype.

Melanotus proteus is based on an 1876 South African collection by Kalchbrenner. Whether or not collections recently reported from Europe as *M. proteus* are genetically the same as the South African organism remains to be seen. Two of the isotype collections examined were not found to differ significantly from any other collections identified as *M. proteus*, *M. horizontalis*, or *M. textilis*. Fresh material and monokaryon cultures are needed from the topotype locality in order to assess congruity with the European *M. proteus* ss. Watling and Gregory (1987). The differences in spore wall thickness (thick vs. thin) reported by Van Waveren (1979) and Pegler (1977, 1986), between *M. proteus* and *M. horizontalis* were found to be insignificant based on isotype material of *M. proteus* and epitype material of *M. horizontalis*, as wall thickness was less than 1 μm in all collections examined.

Mucus Layer on Pileipellis:

Van Waveren (1979) was the first to report on a narrow gelatinized layer in the pileus tissue of *M. proteus*. Watling and Gregory (1987) also reported that a British collection of *M. textilis* exhibited a pileipellis with "membranes slightly gelatinized." When weather conditions permit, the viscid translucent-striate condition of the pileus can be readily observed, but when basidiomata are dry, they appear tomentose.

The ability to visualize the mucus appears to be dependent on: 1) the age of the dried collections; 2) obscuring caused by a spore deposit on the pileipellis; and 3) thickness of the section. Van Waveren (1979) first reported such gelatinized tissue in *M. proteus*, while other descriptions of *M. proteus* have reported a gelatinized area as being absent (Pegler, 1977, 1986; Reid, 1975; Pilát 1950; Horak, 1977). In a generic diagnosis of *Melanotus* Watling (1987) stated that the "cap cuticle consists of filamentous, non-inflated, clamped, +/- moderately encrusted hyphae seated on a more gelatinized zone." When fresh basidiomata are examined, no pellicle can be peeled off as in some other taxa that undergo gelatinization of parts of the pileipellis, (i.e. certain *Psilocybe* taxa, and many *Suillus* species). The pileus surface can be hygrophanous and viscid when fresh, soon drying minutely tomentose. This tomentose condition is expressed microscopically by a lattice-like arrangement of externally incrusting hyphae that are more or less radially arranged, with the hyphal ends becoming erect and often giving rise to individual forked elements. Additionally, when there is sufficient moisture, the pileus margin of *Melanotus* basidiomata can be translucent-striate.

Pleurocystidia in *Melanotus*:

According to Horak (1977), Singer (1951), Watling and Gregory (1987), Pilát (1950), and Pegler (1977, 1986), *Melanotus* lacked pleurocystidia, but Ammirati *et al.* (1979) reported pleurocystidia in *M. hartiae*, the first such report in the genus. The widespread presence of pleurocystidia in the *Melanotus* collections we have examined corroborates the latter observation.

Most pleurocystidia are subtly longer in length than basidia (up to 6 μm), and are easily overlooked. On some lamellae they are abundant, but on others they may be scattered to rare. In no instances were any protuberances noted at the apex of the pleurocystidia suggesting sterigmata (i.e. that they were aborted basidioles), in fact, an apical drop was often observed at the apex of pleurocystidia. Watling (1971) has suggested that the origin of various types of pleurocystidia may be sought in

modifications of some basidia. It is not the intention of this paper, however to speculate on structure or origin of these pleurocystidia.

Intercompatibility and Biogeography:

Based on intercollection pairings of monokaryon isolates, Pacific coastal North American representatives belong to the same biological species (= intersterility group) as representatives from the United Kingdom. Determining a center of origin for the species is beyond the scope of this paper, especially because our most recent experiments may extend the distribution to include Australasia and South America (unpubl. data). A humid mesothermal climate with year-round moisture dominates both the moist forests of the West Coast of North America and the United Kingdom, so climatic factors would appear similar over much of the range. Substratum choice appears to be taxonomically irrelevant, as field collections were found to inhabit a variety of rotting substrata, including introduced as well as endemic native wood and other materials.

Several authors (Donoghue, 1985; Mishler, 1985; Mishler and Donoghue, 1982) have challenged the biological species concept as conceived by Mayr (1942, 1963) and Dobzhansky (1937). We acknowledge that the presence of clamp connections and dikaryons in intercollection crosses (i.e., intercompatibility) is not synonymous with interfertility, but such observations do indicate shared or potentially shared gene pools, the cornerstone of the biological species concept. The fact that putative hybrids from the intercollection crosses were stable in repeated clonal transfers, and formed extensive mycelial mats also suggest a close genetic relationship (Boidin, 1986).

The fact that a few of the Pacific Northwestern SBIs were partially interINcompatible is not unusual. Other workers (Boidin, 1971, 1986; Hallenberg, 1991; Gordon and Petersen, 1992; Petersen, 1995) have discussed partial compatibility of geographically local and distant populations of hymenomycetes. Such conjecture is not the objective of this paper.

Based on the intercontinental sexual compatibility exhibited by these *Melanotus* collections, populational homo-/heterogeneity must be tested by biochemical and/or molecular techniques in order to suggest ancient or recent separation of the populations. Future research will include analysis along these lines.

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AN APOLOGY

We apologize here to authors of the paper "Mycena californiensis resurected" published in volume 70 for a mixup which permitted page 92 to be printed twice, once as page 92, and again as page 93, and that page 93 was not published. It is not clear whether the problem arose in the authors' submission or in the Editor-in-Chief's office. For reader's convenience we have decided that republication of the whole article, retaining the original pagination (volume 71 pagination appears in square brackets), is appropriate.

Pavel Lizoň
Editor-in-Chief

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MYCENA CALIFORNIENSIS RESURRECTED

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Abstract: *Agaricus (Mycena) californiensis*, first described by M.J. Berkeley and M.A. Curtis in 1860, represents a common species found in the oak woodlands of California. The species is redescribed, illustrated, and compared with morphologically similar taxa. *Mycena elegantula* Peck is proposed as a synonym.
Key words: Agaricales, California agarics, *Mycena*, taxonomy.

Our current investigation of California species of *Mycena* indicates that *Mycena californiensis* (Berk. & M.A. Curtis) Sacc. is a species common to the coastal oak woodlands of the state. For years, California investigators have collected what was generally identified as *M. elegantula* Peck (1895) or *M. sanguinolenta* (Alb. & Schwein.: Fr.) P. Kumm., on the leaf litter of *Quercus agrifolia* Nee and a few other *Quercus* spp. Upon microscopic examination of these collections, most appeared to share characteristics with *M. elegantula*. One odd character however, was the presence of pigmented laticiferous hyphae throughout the stipe and tramal tissues of all collections. While this character would be expected in those species reported to contain colored latex such as *M. sanguinolenta*, this character has never been reported for *M. elegantula*. Recent collections made by us all contained copious amounts of reddish to orangish red latex.

Investigation of the literature for species superficially resembling *M. elegantula*, revealed the relatively unknown taxon *M. californiensis*, which was described from a single collection made during the U. S. North Pacific Exploring Expedition, 1853-1856. The material was collected by the expedition botanist, Charles Wright, on oak leaves at Mare Island Naval Yard, Solano

Co., California, in January of 1856 (notes with specimen; Pfister, 1978). The collection was presumably sent by M.A. Curtis to M.J. Berkeley in England, and was published as *Agaricus californiensis* Berk. & M.A. Curtis (Berkeley & Curtis, 1860). Unfortunately the published description of the species is very brief, and the existing type specimens are of very poor quality. Smith (1947) included *Mycena californiensis* in the "excluded and doubtful species" portion of his monograph on the genus, stating that the species "cannot be recognized until the microscopic characters of the type are known." Maas Geesteranus (1982, 1992a) investigated the holotype material (K), but was unable to distinguish any defining characters due to the poor state of the collection. Based on his examination of the holotype material, Maas Geesteranus agreed with Smith's view of the species.

We were able to resolve sufficient information from the isotype material of *M. californiensis* [housed at FH(!) and accompanied by Wright's original notes on the material] to conclude that it is conspecific with the commonly encountered oak loving species from California. Investigation of the holotype material of *M. elegantula* revealed that this species is conspecific with the isotype material of *M. californiensis*. Due to the later publication date of *M. elegantula* (Peck, 1895), the binomial *M. californiensis* has priority. The placement of *M. elegantula* as a synonym of *M. californiensis* is therefore proposed.

We present here a more comprehensive description of *Mycena californiensis* based on its isotype (FH!), on the holotype of *M. elegantula* (NYS!), and on numerous other specimens from California. In the description that follows, color terms and notations are from Kornerup and Wanscher (1978); spore statistics include: $\bar{x}_r$ the range of spore means where $\bar{x}$ is the arithmetic mean of the spore length by spore width for n spores measured in a single sample (specimen), $\bar{x}_m$ the mean of all spores measured ($\pm$ SD); Q , the quotient of spore length and spore width in any one spore, indicated as a range of variation in n spores measured; Q_r , the range of Q -values where Q is the mean of Q -values in a single sample; Q_m , the mean Q -value for all spores measured ($\pm$ SD). All specimens are deposited at SFSU unless specified otherwise. Frequently cited collectors are abbreviated as follows: D. E. Desjardin (DED), Harry D. Thiers (HDT).

Mycena californiensis (Berk. & M.A. Curtis) Sacc., Syll. Fung. 5: 255. 1887.

≡ *Agaricus californiensis* Berk. & M.A. Curtis, Proc. Amer. Acad. Arts 4: 112. 1860.

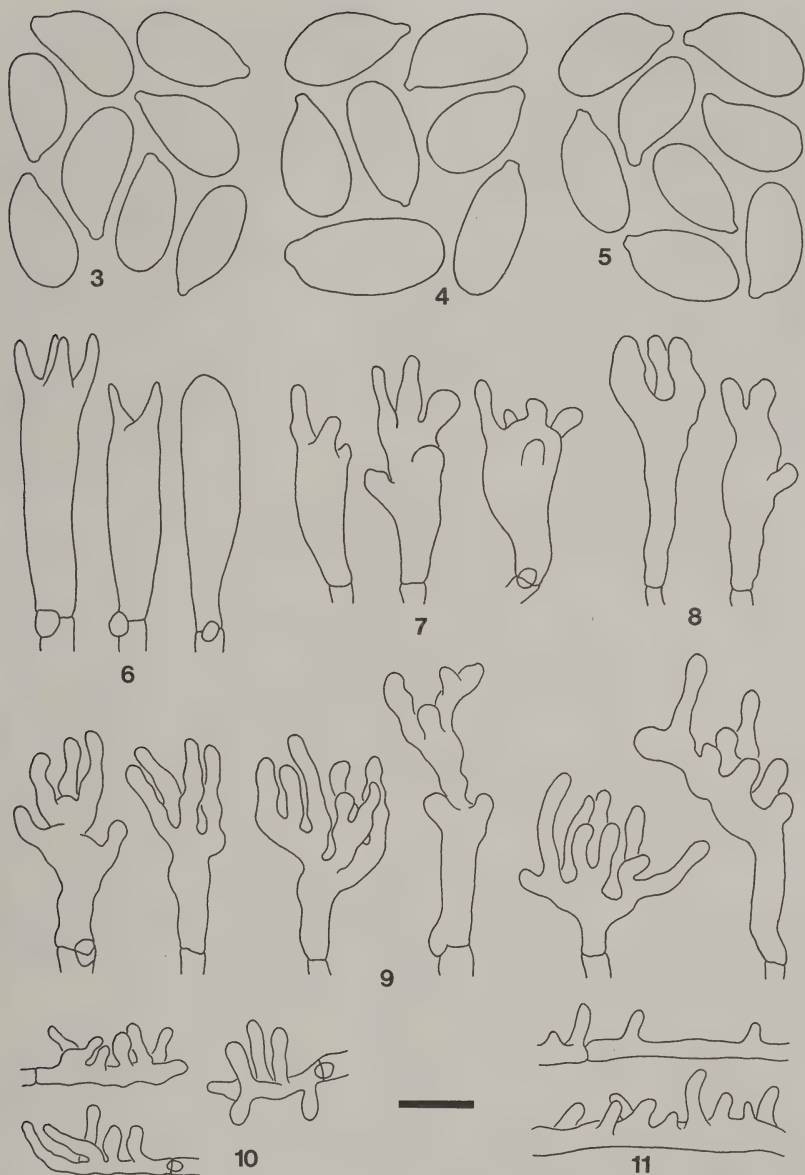
= *Mycena elegantula* Peck, Bull. Torrey Bot. Club 22: 199. 1895.

Basidiomes (Figs. 1-2) gregarious to subcaespitose, putrescent. **Pileus** 6-20 mm, obtusely conic to campanulate when young, generally with incurved margins, remaining so with age or expanding to broadly campanulate at maturity, occasionally becoming convex-umbonate; margin entire when young, often becoming wavy or crenate with age, sometimes splitting, striate or striatulate, extreme edges often staining or bruising darkly, pellucid striate; surface dull, moist to dry, glabrous; at first disc dark brown (8F5-6) to reddish brown (9D-F7-8), in age ranging from brownish red (8C6-8) to reddish brown (8D-F5-8), margin generally lighter, grayish red (8C4-6) to reddish brown (8D-E5-7), or brownish orange (7C5-6) when young, in age fading to grayish orange (6B3) or brownish orange (6C3). **Context** thin, concolorous with pileus or paler, often staining dark reddish. **Lamellae** (Fig. 2) ascending adnate to adnate, often with a short decurrent tooth, close to subdistant (15-20) with 1-2 series of lamellulae, moderately broad (1-3 mm), convex; white to pinkish buff, edges reddish brown (9C-D8), reddish orange, or brownish orange. **Stipe** 29-130 X 1-2 mm, central, terete, ±equal, rarely compressed or cleft, dull to shiny, moist to dry, hollow, apex glabrous to pruinose, glabrous below, base covered with strigose to downy tomentum ranging from buff to some shade of orange or pink; apex brownish orange to light brown (7C-D5-8), reddish brown (8D5-6), or grayish red (8C4-6), some fading in age to lighter brownish orange (5-6C4-6), base concolorous or slightly darker; tissue exuding a brownish orange (7C6-8) to reddish brown (9-10D8) or violet brown (11F7-8) latex when cut.

Basidiospores (Fig. 3-5) 8.0-12.0 (-13.0) X 4.0- 6.0 (-6.7) μm [$\bar{x}_r = 9.1-11.0$ X 4.9-5.6 μm , $\bar{x}_m = 9.7 \pm 0.8$ X 5.2 ± 0.5 , $Q = 1.4-2.4$, $Q_r = 1.8-2.0$, $Q_m = 1.9 \pm 0.2$, $n = 25$ spores per specimen], ellipsoid to amygdaliform, smooth, thin walled, hyaline, weakly to moderately amyloid. **Basidia** (Fig. 6) 26.0-37.5 (- 48.0) X 7.0-10.5 μm , clavate, 4-spored, rarely mixed with 2- spored forms, clamped. **Basidioles** (Fig. 6) clavate,



Figs 1-2. *Mycena californiensis*. 1. Basidiomes (DED 5963). 2. Closeup of lamellar edges (M.Wood s.n.). Scale bar = approximately 10 mm for both figures.



Figs. 3-11. *Mycena californiensis*. 3-5. Basidiospores. 6. Basidia. 7-9. Cheilocystidia. 10. Hyphae of the pileipellis. 11. Cortical hyphae of stipe. (Figs. 3, 7 - Isotype of *Agaricus californiensis*; Figs. 4, 8 - Holotype of *M. elegantula*; Figs. 5, 6, 9, 10, 11 - DED 5963) Scale bar = 7.5 μ m for Figs. 3-5, 10 μ m for Figs. 6-11.

similar to basidia. **Pleurocystidia** absent. **Cheilocystidia** (Fig. 7-9) 16-50 X 6.5-28.0 μm , projections 1.5-18.8 (-30.0) X 1.5-6.5 (-8.0), ranging from contorted-clavate with assorted knob-like projections to irregular in shape, generally with a clavate lower portion and an apical or sublateral portion branching into numerous cylindric projections, these often branching themselves, thin-walled, clamped, with brownish contents that stain darkly in Melzer's reagent. **Pileipellis** (Fig. 10) a cutis; hyphae 1.5-5.0 (-7.0) μm diam, interwoven, covered with abundant cylindric diverticula, 1.5-11.8 (-16.5) X 1.5-2.8 μm , thin-walled, non-gelatinous to subgelatinous, hyaline, inamyloid; terminal cells slightly inflated, otherwise similar to hyphae. **Hypodermium** of inflated cells, 7.0-38.5 μm diam, thin-walled, hyaline, dextrinoid, non-gelatinous; often intermixed with laticiferous hyphae up to 6.5 μm diam, containing brown granular contents. **Hymenophoral trama** dextrinoid, occasionally with laticiferous hyphae as in hypodermium. **Stipe tissues** monomitic; cortical hyphae (Fig. 11) 1.5-6.5 μm diam, parallel, cylindrical, thin walled, covered with scattered to numerous cylindric and occasionally branched diverticula, 2.0-7.0 (-14.0) X 1.0-2.5 μm ; terminal cells slightly broader, 3.8-5.0 μm diam, diverticulate; medullary hyphae broader, 4.5-22.0 μm diam, smooth, thin-walled, hyaline; laticiferous hyphae common, 2.8-8.0 (-11.8) μm diam, usually containing brown granular contents. **Clamp connections** observed in all tissues except stipe medullary hyphae.

Habit, habitat and distribution. Gregarious to scattered, often subcaespitose, on leaves and fruits of *Quercus agrifolia*, *Q. lobata* Nee and *Q. kelloggii* Newb. Abundant and common in the coastal oak woodlands of California.

Material examined. California. Contra Costa Co.: Shell Ridge Open Space, 7 Dec. 1996, B.A. Perry 097. Los Angeles Co.: near Pasadena, 22 Dec. 1894, A.J. McClatchie 810 (Holotype of *M. elegantula*: NYS). Marin Co.: Audubon Canyon Ranch, Picher Canyon, 8 Nov. 1979, C. Calhoun 79-910; Audubon Canyon Ranch, Volunteer Canyon, 19 Nov. 1981, C. Calhoun 81-2597; Corte Madera, Deer Run Road, 11 Dec. 1992, DED 5571; Fairfax, Pine Mountain Fire Road, 1 Feb. 1992, DED 5523; Mt. Tamalpais State Park, Lake Lagunitas, 13 Dec. 1993, DED 5963; Olampali State Historic Park, 2 Dec. 1997, B.A.

Perry 193; Point Reyes National Seashore, Limantour Ridge, 17 Oct. 1981, HDT 43780; same location, 12 Oct. 1981, L. Swaidon 36. Santa Barbara Co.: Santa Barbara, 14 Jan. 1939, Rea Herbarium 16 (MICH); same location, 8 Jan 1940, Rea Herbarium 290 (MICH); La Chacuma, 27 Nov. 1964, HDT 11803. San Diego Co.: Lake Henshaw, San Luis Rey Campground, 10 Mar. 1970, HDT 25052. San Mateo Co.: Wunderlich County Park, Bear Gulch Trail, 26 Nov. 1985, M.T. Siedl 725; San Francisco Watershed, 23 Nov. 1964, HDT 11795; same location, 25 Nov. 1974, HDT 33061. Solano Co.: Mare Island, 13 Jan. 1856, Herbarium of the U.S. North Pacific Exploring Expedition No. 11 (Isotype of *Agaricus californiensis*: FH). Yolo Co.: State Highway 16, 3 mi. west of Rumsey, 15 Nov. 1981, Showers s.n..

Commentary. *Mycena californiensis* is a common component of the oak woodlands of coastal California. The species is characterized by the reddish brown tones to the pileus, stipe, and lamellar edges, and the presence of deep reddish to orangish red latex. Although most of the collections examined were associated with the leaves and fruits (acorns) of *Quercus agrifolia*, the species has also been collected on the leaves of *Q. lobata* and *Q. kelloggii*.

The cheilocystidia of *M. californiensis* may be quite variable in shape and size. Our investigation of the isotype material of *M. californiensis* revealed the presence of generally clavate cheilocystidia with 3-5 apical to sublateral finger- or knob-like diverticula, 3-10 X 2-4 μm . (Fig. 7). The holotype of *M. elegantula* contains cheilocystidia very similar to those seen in the isotype of *M. californiensis*, but also contains some forms that are more apically diverticulate (Fig. 8). Other collections observed in this study revealed a large range of diverticula lengths, reaching up to 18.8 μm (Fig. 9). It was quite common to observe the entire range of cheilocystidia shapes and sizes within a single collection or even a single basidiome.

Our investigation of existing herbarium collections of *M. elegantula* indicate that many of the specimens from both SFSU and MICH actually represent *M. sanguinolenta*, *M. purpureofusca* (Peck) Sacc., or a taxon micromorphologically indistinguishable from *M. renati* Qué. *Mycena californiensis* can be differentiated from these other taxa by a comparison of the cheilocystidia and substrate. While *M. sanguinolenta* is characterized by the presence

of reddish latex, this species is also characterized by fusiform cheilocystidia lacking apical outgrowths. The cheilocystidia of *M. californiensis* are irregular in shape, and have never been observed to be fusiform. Also, all examined California collections of *M. sanguinolenta* appear to be restricted to growth on decaying wood or debris of conifers. *Mycena californiensis* appears to be restricted to the leaves and debris of *Quercus* spp., and has never been observed to be lignicolous. *Mycena purpureofusca* differs from *M. californiensis* in the coloration of the fruiting bodies, which is generally much more violaceous in *M. purpureofusca*, in the absence of pigmented latex, in forming clavate to utriform cheilocystidia, and in growth on coniferous wood. *Mycena renati* has fusiform, subcylindrical and occasionally clavate cheilocystidia, yellow coloration to the stipe, no pigmented latex, and was also reported to grow on conifer wood in the United States (Maas Geesteranus, 1986, 1992b). We have observed that U.S. specimens which are micromorphologically indistinguishable from European *M. renati* lack yellow pigmentation to the stipe and may represent a distinct taxon. *Mycena rubromarginata* (Fr.: Fr.) P. Kumm. is another species that may superficially resemble *M. californiensis*. However, *M. rubromarginata* differs in both habit and cheilocystidia shape, and does not contain colored latex.

It is evident from examination of the type material of *M. elegantula* and the work of Maas Geesteranus (1986, 1992b), that A. H. Smith's concept of *M. elegantula* does not agree with the type material of the species. Smith (1947) reported *M. elegantula* as having clavate to fusoid ventricose cheilocystidia, occasionally with several fingerlike projections, and he reports the species as occurring on decayed conifer wood. Although our investigation of the type material of *M. elegantula* revealed the presence of contorted-clavate cheilocystidia, it contains none that are fusoid-ventricose. The type material of *M. elegantula*, collected from southern California (Los Angeles Co.), is also clearly associated with leaves of *Q. agrifolia*. Investigation of numerous specimens determined by Smith as *M. elegantula*, revealed that his concept of the species (Smith, 1947) was much too broad, encompassing several taxa superficially resembling this species. Maas Geesteranus (1986, 1992b) reported similar findings from his investigation of Smith's material.

The observation of latex and laticiferous hyphae in *M. elegantula* indicates that the infrageneric placement of the taxon

must be reconsidered. Maas Geesteranus (1986, 1992b) placed the species in section *Rubromarginatae* Sing. ex Mass G., presumably due to the reddish lamellar edges and smooth to coarsely diverticulate cheilocystidia. However, none of the species within section *Rubromarginatae* are characterized by the presence of latex. Maas Geesteranus (1988, 1992b) segregates those taxa containing deeply colored latex into three sections: *Sanguinolentae* Maas G., *Galactopoda* (Earle) Maas G., and *Crocatae* Maas G. The placement of *M. californiensis* within section *Galactopoda* can be eliminated since all species of the section are characterized by smooth stipe cortical hyphae, and by stipes that turn black when specimens are dried, features not observed in *M. californiensis*. Of the remaining sections, the monospecific section *Crocatae* may also be eliminated due to the lack of marginate lamellae, pale stipe coloration, and clavate cheilocystidia with short, evenly spaced, cylindrical spinulae. Section *Sanguinolentae* is by far the most accommodating section for *M. californiensis*. The members of section *Sanguinolentae* are characterized macroscopically by reddish brown pileus and stipe coloration, red brown to purple brown lamellar edges, and dull orange to reddish brown latex. Microscopically the members of the section are characterized by cheilocystidia with reddish brown contents forming a sterile lamellar edge and occasionally covered with excrescences, smooth amyloid spores, and various other characters shared with *M. californiensis* (Maas Geesteranus, 1988, 1992b). The placement of *M. californiensis* in section *Sanguinolentae* is therefore proposed.

In addition to *M. californiensis*, the northern temperate members of section *Sanguinolentae* include *M. atkinsoniana* A.H. Sm. and *M. sanguinolenta*. To aid in distinguishing northern temperate *Mycena* species with deeply colored latex, the following artificial key is provided.

Key to Northern Temperate species of *Mycena* with deeply colored latex.

The following key is adapted from Mass Geesteranus (1988, 1992b), Smith (1947) and our own observations.

1. Stipe cortical hyphae smooth; stipe becoming black when dried
..sect. *Galactopoda*....*M. haematopus* (Pers.: Fr.) P. Kumm.
1. Stipe cortical hyphae diverticulate; stipe not becoming black
when dried.....2

2. Lamellar edges white, non-marginate; stipe apex white to orange; cheilocystidia clavate, covered with evenly spaced, short, cylindrical spinulae.....sect. *Crocatae*.....
.....*M. crocata* (Schrad.: Fr.) P. Kumm.
2. Lamellar edges reddish brown to purplish brown; stipe apex light brown, brownish orange, reddish brown or purplish brown; cheilocystidia fusiform or irregularly clavate, smooth or with knob-like to long, cylindrical apical projections.....sect. *Sanguinolentae*.....3
3. Cheilocystidia contorted-clavate to irregular in shape, with irregular knob-like diverticula and/or numerous long, cylindrical apical projections..... *M. californiensis*
3. Cheilocystidia fusiform to subcylindrical or rarely clavate, typically apically narrowed into one or more necks, acute, smooth or with occasional small diverticula.....4
4. Lamellae 23-26 reaching the stipe; basidiomes generally robust, stipe width 2-3 mm, pileus (5-) 10-30 mm broad
..... *M. atkinsoniana*
4. Lamellae 13-21 reaching stipe; basidiomes generally smaller, stipe width 0.5-1.5 mm, pileus 7-18 mm broad
..... *M. sanguinolenta*

Acknowledgments

The authors would like to thank Dr. Don Pfister (FH), Dr. Robert Fogel (MICH), and Dr. John Haines (NYS) for loaning us many of the specimens used in this investigation. We would also like to thank Michael Wood for generously allowing us to use his photograph of *Mycena californiensis* (Fig. 2). We are grateful to Drs. Scott Redhead and Roy Halling for their critical comments on the manuscript.

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MYCOTAXON

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ONLINE RESOURCES FOR FUNGAL TAXONOMY & NOMENCLATURE: Information Quality

Kathie T. Hodge

Maintainer, Mycological Resources on the Internet

<http://biodiversity.uno.edu/~fungi/>

Not chaos-like together crush'd and bruis'd,
But as the world, harmoniously confus'd,
Where order in variety we see,
And where, though all things differ, all agree.

*Windsor Forest
Alexander Pope*

Pope might have been describing the internet in his poem, Windsor Forest. In the harmonious confusion of the internet, a thousand thousand websites proffer information, opinion, and misinformation. And where in traditional media we have relied on others to minimize the misinformation through peer reviewers, editors, book reviewers on the internet the various degrees of truth stand shoulder to shoulder, and a reader must judge their credibility herself.

As maintainer of a library of links, I have decided uncomfortably to include sites that present distorted representations of the truth and fringe theories, and leave it to the reader to evaluate them. In mycology these sins might include misidentification of poisonous mushrooms (which I have not so far observed), mistruths about the code of botanical nomenclature, or the description of fungi as achlorophyllous plants, any of which might be dangerous on one level or another.

Information quality has come to be more of an issue on the internet than in other media, due largely to the ease with which any individual can rapidly and inexpensively post documents to the internet.

I routinely receive email from students asking which site can provide the life cycle of Fungus X, a color guide to the identification of bread molds, the classification of a certain fungus, or a treatment for some possibly fungal skin infection. Students at all levels increasingly rely on internet sources for their research papers, and students are especially susceptible to misinformation.

The information quality issue must be addressed by users of internet resources and by those who create them. If you maintain a web site, be sure to provide information to help your readers judge its credibility. How were these data gathered? and what level of certainty can be associated with, say, a species determination? Has this work been published elsewhere? When was this information current?

Web surfers have a more difficult task. The site below, which describes a fictional tropical vacation paradise in one of America's coldest states, apparently deceived some readers, who arrived expecting warm beaches.

VACATION PARADISE IN MANKATO, MINNESOTA?

<<http://www.lme.mankato.msus.edu/mankato/mankato.html>

As a seeker of information, it might be useful to consider the criteria employed by reference librarians to judge resource quality: Accuracy. Authority. Objectivity. Currency. Coverage. Look for congruence among several sites that cover the same topic. Contact the maintainers of sites that include misinformation.

The following sites provide more detailed guidelines:

PRACTICAL STEPS IN EVALUATING INTERNET RESOURCES

<<http://milton.mse.jhu.edu:8001/research/education/practical.html>

EVALUATING QUALITY ON THE NET

<<http://www.tiac.net/users/hope/findqual.html>>

INFORMATION QUALITY WWW VIRTUAL LIBRARY

<<http://www.ciolek.com/WWWVL-InfoQuality.html>>

It's time now to begin to review web sites, as we do books. James Rettig of the College of William and Mary in Williamsburg, Virginia has written a useful and sometimes hilarious review of information quality and the award and review systems that currently rate the internet:

PUTTING THE SQUEEZE ON THE INFORMATION FIREHOSE

<<http://www.swem.wm.edu/firehose.html>>

Like Windsor Forest, the internet is a magnificent place despite the chaos. Caveat lector.

MYCOTAXON

Volume LXXI, pp. 509-513

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BOOK REVIEWS

Eric H.C. McKenzie, Book Review Editor

Los nombres de los hongos y lo relacionado con ellos en América Latina [*The Names of Fungi in Latin America*] by Gastón Guzmán (1997). 356 pp., 28 plates, 277 x 209 mm. Instituto de Ecología, A.C., Apartado Postal 63, km 2.5 antigua carretera a Coatepec, Xalapa 91000, Veracruz, Mexico. Softcover ISBN 968-786306-4. US\$30. Hardcover US\$50.

This book is a highly informative publication on the ethnomycology of Latin America. It is the culmination of studies made by the author with many indigenous people, over four decades of a life dedicated to the fungi. The book is a catalogue of more than 1700 species of fungi. It is presented as a dictionary of folk names, arranged alphabetically, with their corresponding scientific name. It is the first of its kind for this region. Although the title makes reference to Latin America in general, the majority of the names cited originate from Mexican ethnic groups (náhuatl, maya, purépechas, mazatecos, zapotecos, mixes, tepehuanes, etc.). This does, however, pay tribute to the enormous knowledge of fungi accumulated by these indigenous people, which often went beyond their culinary use to ritual and medicinal uses, and which would be lost in autochthonous popular expressions without this kind of reference. There are also interesting cultural additions such as Mayan stone statues of fungi or the temple to fungi in Mexico.

The main body of the book considers each name, the country of origin and the ethnic group origin of the name, and the scientific name of the fungus. Some line drawings illustrate the most common species as an aid to identification. The dictionary is not however restricted to names of species, but includes, in many cases, linguistic variations, bibliographic references and comments or notes on use, from the pathogenic fungi to fungi in traditional drinks. Of significant value is the extensive bibliography of some 500 references, not only manuscripts on systematics, but also articles and papers spanning the most up to date literature on traditional Latin American knowledge of fungi. A quick guide to use and properties is provided by symbols beside each entry.

The book also has four useful appendices. The first deals with the Mexican ethnic groups cited in the text and their geographical distribution. The second is of common and scientific names of plants from the text parasitised by fungi. The third indexes genera, divisions and subdivisions of fungi, and the last lists all the species of fungi included in the book, in taxonomic order and with their synonyms, for easy reference. A few black and white photographs illustrate the book.

For anyone interested in neotropical fungi, or ethnomycology, this is the book to consult. It will similarly be a valuable reference for anyone working with historical collections or manuscripts from these regions of the world. For the general reader, the taxonomic treatment is somewhat unbalanced, but this well researched volume will delight them with surprises, such as the uses some indigenous cultures make of organisms like the myxomycetes.

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Mushrooms of Northeastern North America by Alan E. Bessette, Arleen R. Bessette and David W. Fischer (1997). 582 pp., 255 x 180 mm. Syracuse University Press, Syracuse. (e-mail: arashap@summon.syr.edu, website: <http://members.aol.com/mycology/monema>). Hardcover ISBN 0-8156-2707-6. \$US95. Softcover ISBN 0 8156 0388 6. US\$45.

This work commences with a brief but informative introduction to collecting and identifying fungi, and a map of the area covered (Canada as far west as Manitoba; and the northeastern United States extending west to North Dakota, and south to North Carolina). There are also appendices on mycophagy, microscopic examination, chemical reagents, classification (a list of the genera covered arranged under subdivisions of the Fungi), along with a glossary and indices to common names and scientific names. The text is clearly laid out, although a few pages of my copy were duplicated.

The intervening bulk of the book is made up of keys to and descriptions of nearly 1500 species of macrofungi, with all major groups covered, from agarics and boletes to coral fungi and cup fungi. The balance of genera and species follows the familiar pattern, with agarics predominating, and many species illustrated in *Cortinarius*, *Hygrophorus* and *Russula*, in comparison to the sole species of equally diverse genera such *Hypoxylon*. There is a nice mix of the familiar and widespread, but also less commonly illustrated genera such as *Callistosporium*, *Cheimonophyllum*, *Chromosera* and *Simocybe*.

The term mushroom is used throughout (without explanation) for all macrofungi, which leads to the unfortunate term 'gilled mushrooms'. The species are arranged under 22 major groups, not always strictly equating to higher taxa, but convenient for identification. The groups are separated in a colour key, with brief explanatory text. This key should work as well as any textual key, although the inclusion of the lamellate *Lenzites* under the Polypores (described as having pores) could be confusing, and only two agarics are illustrated (one stipeless, the other with lateral stipe) in this diverse group where most species are centrally stiped.

The cover depicts in large format a truly luscious *Hygrophorus*, so it is a little disappointing to find that the 650 colour illustrations (included at the end of each major group) are small in comparison, mostly about 7 x 4.5 cm. Nevertheless, on close inspection they are on the whole crisp and true to colour, correctly identified, show diagnostic characters, and depict good quality material either *in situ*, or at least with enough substrate to give a natural feel to the studio shots.

The illustrated species are provided with standardised descriptions of macroscopic and concise microscopic features. Within each major group there is either a key to the included species or, in the larger groups, a key to genera, with keys to species under most genera. While some of the keys appear comprehensive in terms of the species occurring in the area covered, it would be helpful to have an indication of the number of species in each genus known from the region, so as to prevent the possibility of identifying material of other species as those included.

In the keys, numerous species additional to those illustrated are included, often with several lines of description. The descriptions in the keys might better have been included along with the descriptions of illustrated species — space for the descriptions of which easily could have been condensed by less indentation, and running on of paragraphs. This would simplify the keys, which at some steps include more than one alternative (up to five). A feature of the keys is the emphasis on macroscopic characters and non technical language. Nevertheless, it is probably easier to identify species from a quick flick through the illustrations, rather than wading through such unwieldy keys. *Mushrooms of Northeastern North America* is no different in this regard from other field guides which struggle to provide workable keys. It is high time for adoption of new identification methods (such as computer assisted multiple access or synoptic keys).

Mushrooms of Northeastern North America, with its quality illustrations of a diverse array of taxa, comprehensive descriptions and extensive keys, compares well with Phillips' *Mushrooms of North America* (more illustrations, but no keys) and Arora's *Mushrooms Demystified* (keys and plenty of text, but less colour illustrations). For those wishing to identify macrofungi in the area covered by this book, this is clearly an indispensable work. It will also be useful in temperate regions in both hemispheres, both at the generic level (given the extraordinarily wide distribution of most genera of macrofungi) and as a source of information on the many species of wide distribution.

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Biodiversity of Tropical Microfungi edited by Kevin D. Hyde (1997). 421 pp., 240 x 165 mm. Hong Kong University Press, Hong Kong. (e-mail: hkupress@hkucc.hku.hk). Softcover ISBN 962-209-422-8. \$US50.

It is difficult to understand why there is such a disproportionate interest in life (or the lack of it) on other planets when there is so demonstrably a multitude of unexplored life on earth, especially among the fungi. The tropical microfungi undoubtedly form the bulk of the fungi, and Rossman, in the introductory chapter of this excellent book, aptly refers to tropical microfungi as 'an unexplored universe of biodiversity'. This collection is a timely compilation of knowledge, or the lack of it, on biodiversity of tropical microfungi, focussing on Ascomycetes and Deuteromycetes.

Biodiversity is interpreted as 'what species are present, their habitats and functional roles' and the bulk of the book is a series of chapters on functional, ecological or taxonomic groups by specialists in each field. There are overviews of tropical fungi and the pharmaceutical industry (Wildman), tropical plant pathogens (Shivas & Hyde) and

invertebrate pathogens (Hewyl-Jones). Fungi associated with particular substrates or habitats are dealt with in chapters on endophytes (Rodrigues & Petrini), mangrove fungi (Jones & Alias), ascomycetes on palms (Hyde, Frölich & Taylor), microfungi on Pandanaceae (McKenzie & Hyde), freshwater ascomycetes (Hyde, Wong & Jones) and freshwater Hyphomycetes (Goh). Taxonomic overviews are presented for tropical lichenised fungi (Aptroot & Sipman), Laboulbeniales (Weir & Hammond), Discomycetes (Korf), Rhytismatales (Johnston), Phyllachoraceae (Cannon), Xylariaceae (Whalley) and Hypocreales (Samuels). The book concludes with three chapters on microfungi from particular regions - Loculoascomycetes and Pyrenomycetes from French Guiana (Huhndorf), and microfungi from Brazilian forests (Pfenning) and Cerrado (Dianese, Medeiros & Santos).

Some chapters emphasise taxonomic aspects, others ecological or biogeographic, but there is a cohesiveness created by good editing. The book is attractively laid out and with some illustrations (several in colour) to break the text, and give readers a glimpse of the diversity of tropical microfungi. There is much useful information, often well-summarised in tables, such as lists of collectors of Discomycetes and of Phyllachoraceae; and for Hypocreales a list of recent taxonomic treatments and a key to common tropical members of the order. For less diverse groups of fungi, well-annotated comprehensive lists are provided, as for example for host specific mangrove fungi, freshwater Ascomycetes and Hyphomycetes, and fungi with *Pandanus* or *Freycinetia* as the type substrate.

There is also much to challenge and stimulate. Paul Cannon presents a detailed examination of the diversity of Phyllachoraceae, based on the comparatively well-studied mycotas of the Dominican Republic and Puerto Rico. By use of extrapolation based on complementarity (degree of dissimilarity) for fungi and for vascular plants from the two regions, and on land area, a figure of 157,800 species of Phyllachoraceae worldwide is arrived at, less than 1% of which have been named. In such trains of arithmetic there are many assumptions, but as Cannon states, the figure of 9.9 million which he then extrapolates for worldwide fungal diversity does suggest that the 1.5 million estimate of Hawksworth (1991) is 'not an over-estimate'!

Mycologists are now moving from a phase of having to postulate and defend the vastness of fungal diversity, to a period when new taxonomic and ecological techniques must be introduced to cope with such megadiversity. Hyde & Hawksworth, in their chapter on measuring and monitoring the biodiversity of microfungi, discuss methods such as the use of permanent plots and indicator species, and an all-taxa biodiversity inventory of fungi, while rejecting rapid biodiversity assessment as an impractical and ultimately unrewarding approach to monitoring microfungi. The all-taxa inventory is elaborated by Rossman as a means of providing at least one accurate data set for calculation of the ratio of fungi to vascular plants (among various hypotheses that could be tested), and also allows development of suitable survey protocols for the various ecological and taxonomic groups of fungi. Other chapters also shed light on the practical problems of measuring and monitoring fungal biodiversity.

Biodiversity of Tropical Microfungi is a stimulating work which will be an essential text on tropical fungi. There is some overlap of authors and topics with *Aspects of Tropical Mycology* (eds Isaac *et al.*, 1993) and *Tropical Mycology* (eds Janardhanan *et al.*, 1997), but the work under review definitely complements and updates these other works. It is not

only those working on tropical microfungi who will be interested in *Biodiversity of Tropical Microfungi*, since the vast tropical microfungi must be taken into account by all mycologists seeking to understand fungal ecology and evolution.

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British Fungus Flora, Agarics and Boleti 8. Cantharellaceae, Gomphaceae and Amyloid- Spored and Xeruloid Members of Tricholomataceae [excl. Mycena] by Roy Watling and Evelyn Turnbull (1998). iv + 189 pp. Royal Botanic Garden Edinburgh. Available from Print & Publications Section, Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh EH3 5LR, U.K. (e-mail: pps@rbge.org.uk). ISBN 1-872291-82-1. £12.50 (excluding postage).

Number 8 is the latest addition to the *British Fungal Flora* which, as the subtitle states, is primarily made up of members of the Agaricales. The book is arranged by family with keys to the genera, and subsequently generic treatment with keys to the species. The coverage includes the Cantharellaceae, Gomphaceae, and several elements of the Tricholomataceae sensu lato. Included are seventeen amyloid spored genera and fourteen genera assigned to the Xerulaceae by Redhead in 1987. Family and generic descriptions and keys are provided, along with macroscopic and microscopic descriptions of all 116 species. An extensive list of references is included and sorted by family, with subject categories in some cases. An appendix has an "Ecological list of species" indicating the plant communities and substrates where each species is most likely to be found. In addition, an index of synonyms, misidentifications, and rejected names is provided. An index of epithets mentioned in observations is listed separately from the index to the species described. Lastly, seven plates containing 134 figures contain habit sketches of basidiomata, spores, and cystidia, and other macroscopic features of the described taxa are included. This work, like the others in this series, gives excellent information concerning the critical characters necessary to identify the taxa. The flexible but tough soft cover, firm binding, and size make the work easy to carry and use. Many of the species have wide distributions and yield invaluable accounts of taxa known and first described in Europe, which is a decided advantage in comparing taxa on other continents. I have used other numbers of this series to advantage many times, and recommend the latest work to both professional and amateur mycologists everywhere.

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Page 36, line 15	for <i>celomycete</i>	read <i>coelomycete</i>
Page 38, line 19	for <i>relatedbecause</i>	read <i>related because</i>
Page 56, line 25	for <i>neotype</i>	read <i>lectotype</i>
Page 56, line 43	for <i>a neotype. Therefore the neotype</i>	read <i>holotype. Therefore, the lectotype</i>
Page 61, line 38	for <i>versicoloures</i>	read <i>versicoloured</i>
Page 62, line 43	for <i>ir</i>	read <i>is</i>
Page 65, line 9	for <i>families</i>	read <i>genera</i>
Page 96, line 15	for <i>griseocyaneum</i> var.	read <i>griseocyaneum</i> (Fr.:Fr.) P. Kumm. var.
Page 98, line 20	for <i>griseocyaneum</i> var.	read <i>griseocyaneum</i> (Fr.:Fr.)
	<i>griseocyaneum</i> (Fr.: Fr.) P. Kumm.	P. Kumm. var. <i>griseocyaneum</i>
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ERRATA

VOLUME SIXTY-NINE

- Cover pg. 1, line 30 for *Beir Mathiassen* read *Geir Mathiassen*
 (as well as on page iii, line 28, page 523, line 13, and page 524, line 18)
- Page 424, fig. 2 *photographs should be reversed and rotated by 180°*: as printed, the left photograph represents spores of *Amylostereum chailetii* and the right one spores of *A. areolatum*

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- Page ii, line 34 for 1998 read 1999

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